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ROENTGENOLOGICAL EXAMINATION AND EVALUATION OF THE ILEOCECAL VALVE

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THE attention of radiologists was first focused on the region of the ileocecal valve in 1943 by Golden[3] who described 2 cases of enlargement of the valve. An excellent basic contribution to knowledge along this line was made by Fleischner and Bernstein[1] in their roentgen-anatomical studies of the normal ileocecal valve. Their presentation was based upon the study of 50 consecutive ileocecal valve specimens obtained at autopsy, and a review of 2,000 barium enema examinations. The authors emphasized the typical appearance of the ileocecal valve as seen end on and in profile.

Hawley and Mithoefer[4] recently described 2 cases showing marked prolapse of the ileal mucosa into the cecum, causing defects which closely simulated tumor. Prolapse of the lower lip of the ileocecal valve backwards into the terminal ileum has been reported by Rigler and Lasser.[5]

At the ileocecal junction there is a transition in caliber from small to large, a change in mucosal characteristics and a modification in muscular physiology. This transition is similar to that which occurs at the junction of the stomach with the duodenum. All radiologists are familiar with elongation, narrowing, hypertrophy and edema of the pylorus, and the common occurrence of prolapse of gastric mucosa into the duodenal bulb. We are still in the process of learning about the many deviations from normal which may be encountered at the more complex ileocecal valve.

Roentgenoscopy and roentgenography offer us means of studying anatomy and physiology in vivo in an area which has been previously investigated only by anatomists and surgeons. It is well known that anatomical changes occur and physiological processes cease under general anesthesia or at necropsy, and it is evident that there is a great need for further study of the ileocecal valve under conditions which approach physiological normality.

When ileocecal valve defects were first observed roentgenologically, it was generally believed that they were rarely encountered. Subsequent literature and recent personal experience have shown that

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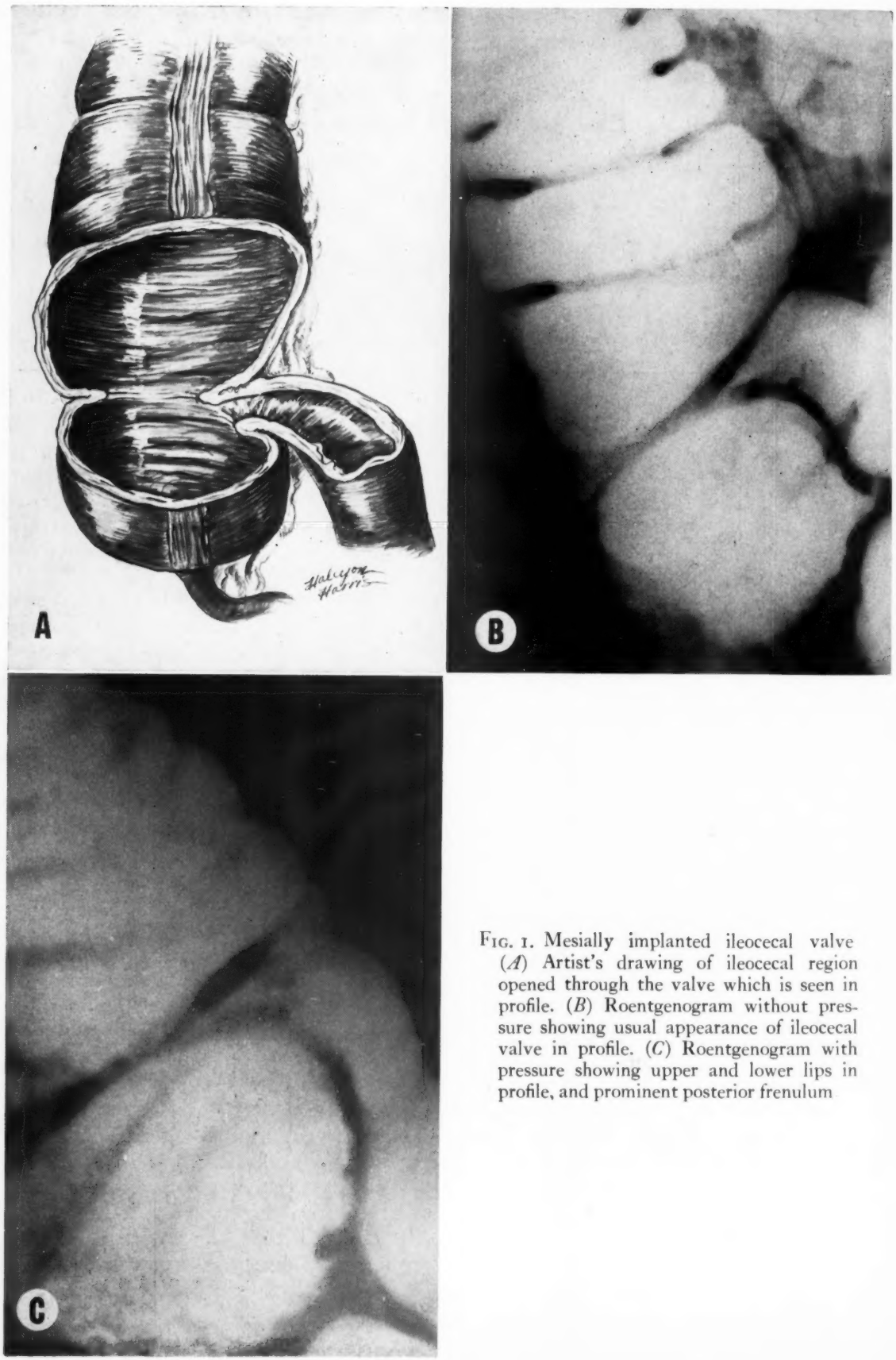

FIG. 1. Mesially implanted ileocecal valve (*A*) Artist's drawing of ileocecal region opened through the valve which is seen in profile. (*B*) Roentgenogram without pressure showing usual appearance of ileocecal valve in profile. (*C*) Roentgenogram with pressure showing upper and lower lips in profile, and prominent posterior frenulum

the defect produced by the valve can be identified and demonstrated roentgenologically in the vast majority of instances in which barium is introduced into the ileum on barium enema examination.

We have paid particular attention to the ileocecal valve in the past year and have attempted to visualize and evaluate the defect produced by it in our last 500 barium enema examinations. On review of this material we find that barium was introduced into the ileum in 92 per cent. In essentially every case the ileocecal valve was recognized by the simple expedient of applying graduated pressure to the abdominal wall over the ileocecal region.

The defect in the barium-filled cecum varies in size, position, and shape, depending upon the size, position, shape and thickness of the valve lips and the presence or absence of ileal prolapse. Identification of the valve can be accomplished in questionable instances by securing face on and profile views. Oblique projections with pressure are readily secured and are extremely valuable.

SITE OF IMPLANTATION

In our series, the ileocecal valve has been found to be implanted (roentgenoscopic localization) in the following locations: posteromesially in 90 per cent, posteriorly in 8 per cent, near the posterolateral margin in 1 per cent. In the remaining 1 per cent, the ileum was implanted elsewhere or could not be located satisfactorily. The appearance is influenced markedly by the site of implantation.

(a) *Mesially Situated Valve.* When the valve is situated mesially, it is seen in profile and is readily identifiable. Although it may bear a resemblance to a spindle, a funnel, a shark mouth, a polypoid rosette or an ampullary projection, it is not readily mistaken for any other structure. Some valves of this type are illustrated in Figure 1. If desired, the valve may be observed end on by rolling the patient toward his left in the right anterior oblique projection.

(b) *Posteriorly Situated Valve.* When posteriorly situated, the thick protruding valve lips displace the barium, producing a spongy, ovoid, snow-shoe or spindle-shaped filling defect, in the central portion of which a slit or modified star of ileal lumen is found. This, of course, represents the actual valve plus the ileal mucosal pattern seen face on. When this appearance is observed, it can be intensified by the application of diffuse pressure over the area with the patient supine. Several posteriorly situated valves are illustrated in Figure 2.

When such a patient is rolled toward his right (left anterior oblique position) the valve defect presents mesially and appears in profile, exactly as described under mesially situated valves. When the same patient is rolled toward his left (right oblique position), the defect presents on the lateral cecal margin as an ovoid or fat spindle-shaped indentation which merges into the posterior shelf or frenulum of the superior lip, as shown in Figure 3.

ACCESSORY ROENTGENOLOGICAL STUDIES

Large valves can often be seen on postevacuation films. Here the cecum contracts down about the soft spongy mass, producing an appearance indistinguishable from that of a polyp. The postevacuation film is worthless as a means of differentiation or identification (Fig. 4).

Air contrast examinations are of some interest, as they afford a means of demonstration of the mucosal surfaces of the perivalvular bulge and the valve itself surrounded by air. In our experience, this examination exaggerates the defect and enhances the possibility of confusion with a polyp or polypoid tumor (Fig. 5).

We do not believe that the postevacuation study or air contrast study should be given credence until after the ileocecal valve has been identified postively with the cecum and terminal ileum filled with barium. After the valve is identified, these accessory studies often furnish confirmatory evidence.

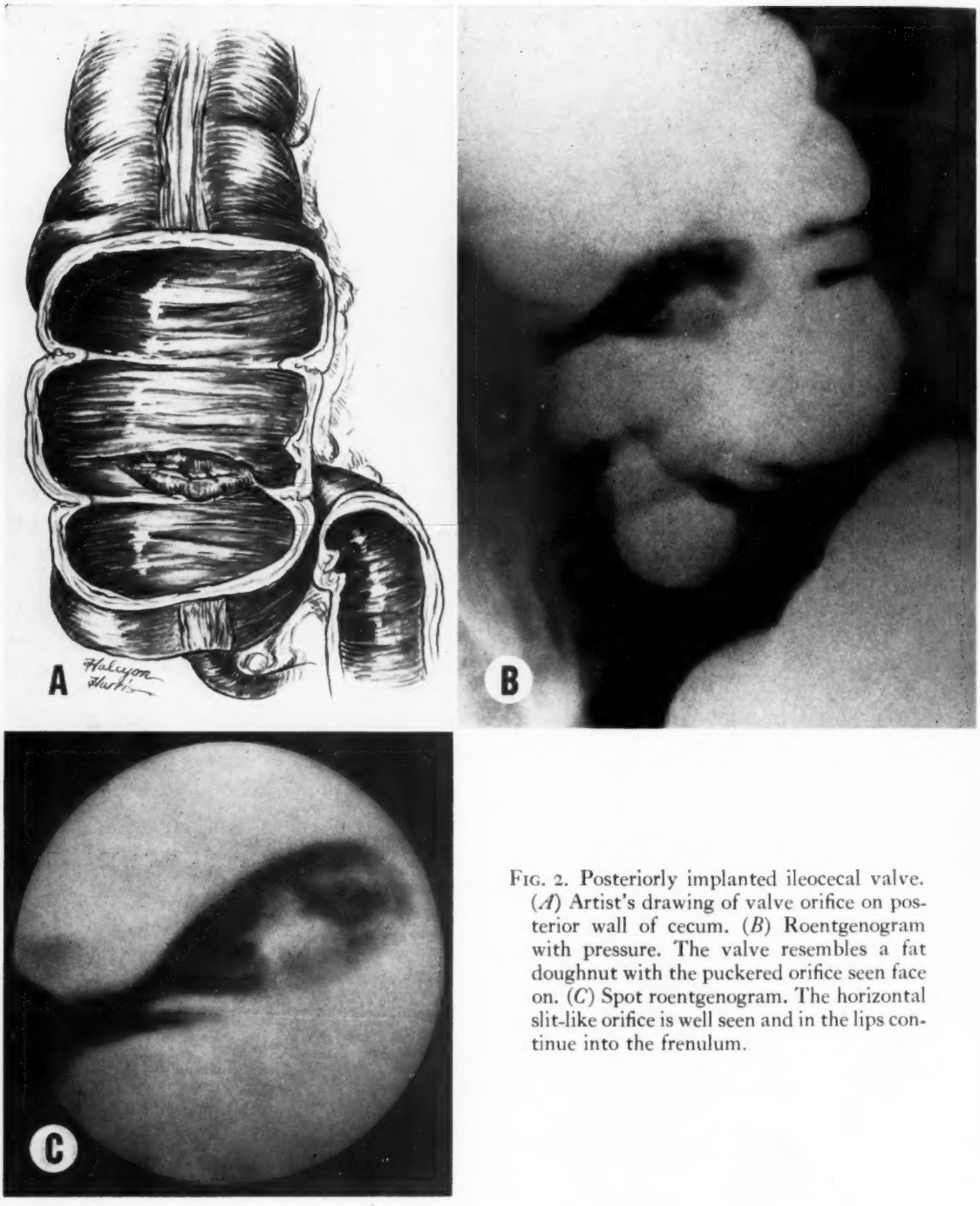

FIG. 2. Posteriorly implanted ileocecal valve. (*A*) Artist's drawing of valve orifice on posterior wall of cecum. (*B*) Roentgenogram with pressure. The valve resembles a fat doughnut with the puckered orifice seen face on. (*C*) Spot roentgenogram. The horizontal slit-like orifice is well seen and in the lips continue into the frenulum.

RECOMMENDED SUPPLEMENTARY STUDIES

Earlier writers dealing with ileocecal valvular defects have stressed the high incidence of associated segmental ileitis[3,6] and other small intestinal disease. For this reason it is probably wise to conduct a small intestinal study for completeness. We have done this in 5 of our larger defect cases but have found no evidence of associated abnormality. None of these patients had signs or symptoms of gastrointestinal disease.

In most cases, the intracecal defect is less obvious when studied in this manner than

on barium enema examination. Since the cecum usually contains fecal material, the defect is readily confused with or obscured by such material. It is our impression that the routine use of castor oil and cleansing enemas in preparation may cause edema of the valve and probably exaggerates the ileal prolapse so often seen on barium enema examination.

A minimum medical or preoperative study in cases of this kind should include a complete blood count, and examination of the stool for ova, parasites and occult blood.

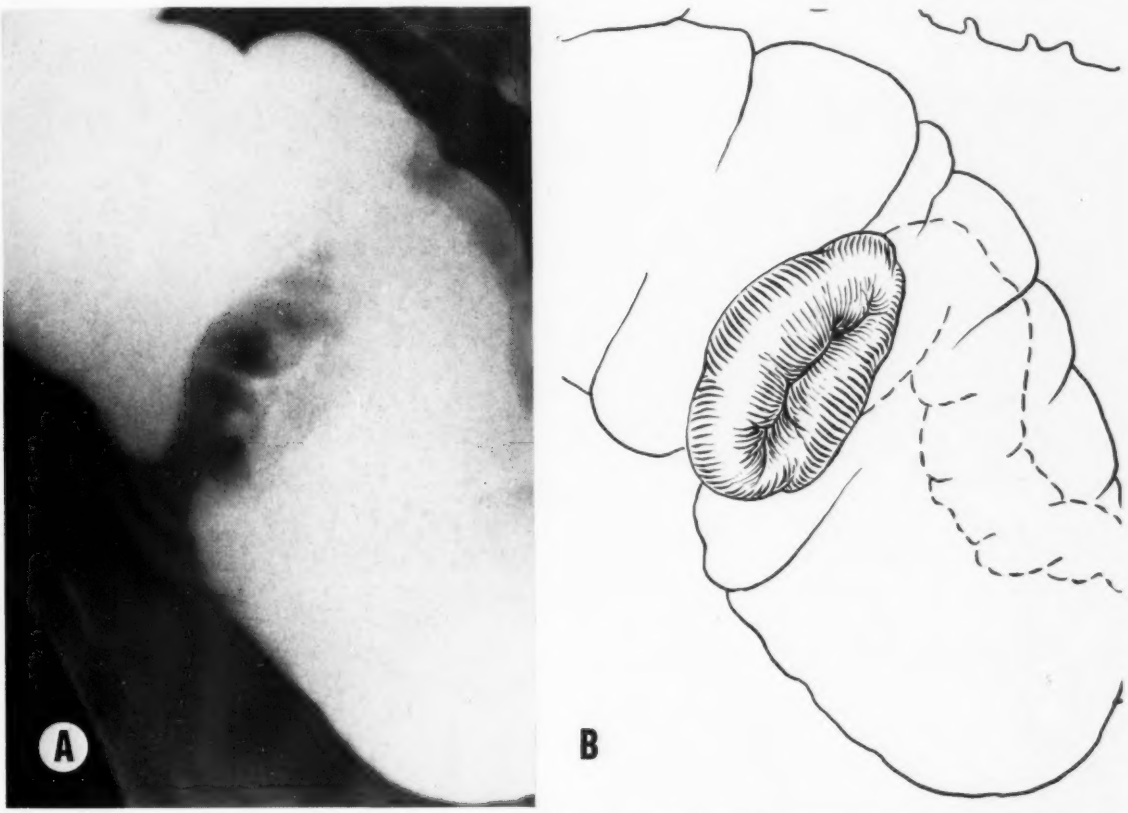

Fig. 3. Oblique projection. (*A*) Pressure spot film. Posteriorly situated ileocecal valve presenting laterally in the right anterior oblique projection. (*B*) Line drawing of (*A*).

FURTHER EVALUATION OF DEFECTS ENCOUNTERED

When an unusually large, or otherwise conspicuous ileocecal filling defect is encountered, it is highly desirable to identify the components responsible for it, if possible. Ideally, one should be able to determine whether the defect is the result of enlargement of the valve itself or whether it is the result of ileal prolapse, but in our experience, at least, this is seldom possible.

One cannot always recognize mucosal characteristics accurately enough to determine whether the filling defect is covered with colonic mucosa over thick valve lips or whether the lips are separated by prolapsed mucosa from the ileum. Invaginated ileal mucosa tends to be more wrinkled, puckered and finely granular than colonic mucosa, and may form a clear cut rosette, as in Figure 6*A*. When the defect has a smooth surface and is cone shaped, with a clear cut central star or slit, we feel justified in attributing the appearance to the ileocecal valve proper, rather than to mucosal prolapse (Fig. 6*B*).

The over-all size of the defect is of some importance in evaluation. At the time of this writing, the range in size of normal

ileocecal valves has not been determined, but adiposity of the lips may result in thickening to a diameter of 2 cm.,[1] and certain factors cause valves, which are probably normal in size, to stand out in a conspicuous manner. In our series we find that most valve defects measure 2.5 cm. in vertical diameter on pressure films, and we consider that defects exceeding 4 cm. in vertical measurement are probably abnormal. Variations in transverse diameter are more likely to be the result of pressure, obliquity or congenital variations.

Based upon available literature and our own experience, the causes of conspicuous filling defects at the ileocecal valve may be listed as follows:

1. Unusually conspicuous ileocecal valve of normal size.
   (a) Pericecal and retrocecal adhesions
   (b) Retrocecal mass
   (c) Posterior implantation of the ileum on the cecum
   (d) Common ileocecal wall
2. Unusually large ileocecal valve.
   (a) Edema of lips
   (b) Hypertrophy
   (c) Fatty infiltration
   (d) Tumor of the valve lips
3. Invagination or prolapse of soft tissue through the valve.
   (a) Normal ileal mucosa
   (b) Abnormal ileal mucosa
4. Combinations of the above.

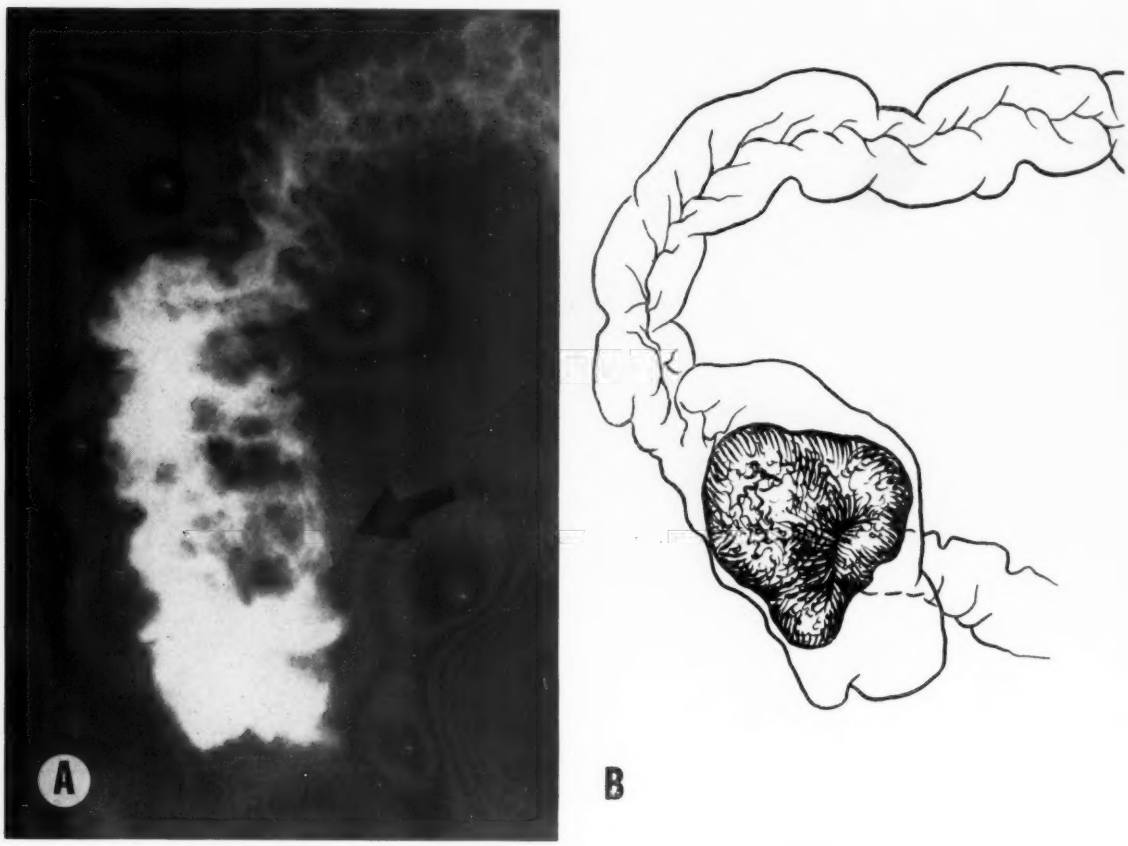

FIG. 4. Postevacuation film. (*A*) Roentgenogram following evacuation of barium enema. The filling defect simulates a large polyp. (*B*) Line drawing of (*A*).

DIFFERENTIATION FROM TUMOR

Benign and malignant tumors of the ileocecal valve proper have been described and must be considered in differential diagnosis, but the incidence of malignant tumor

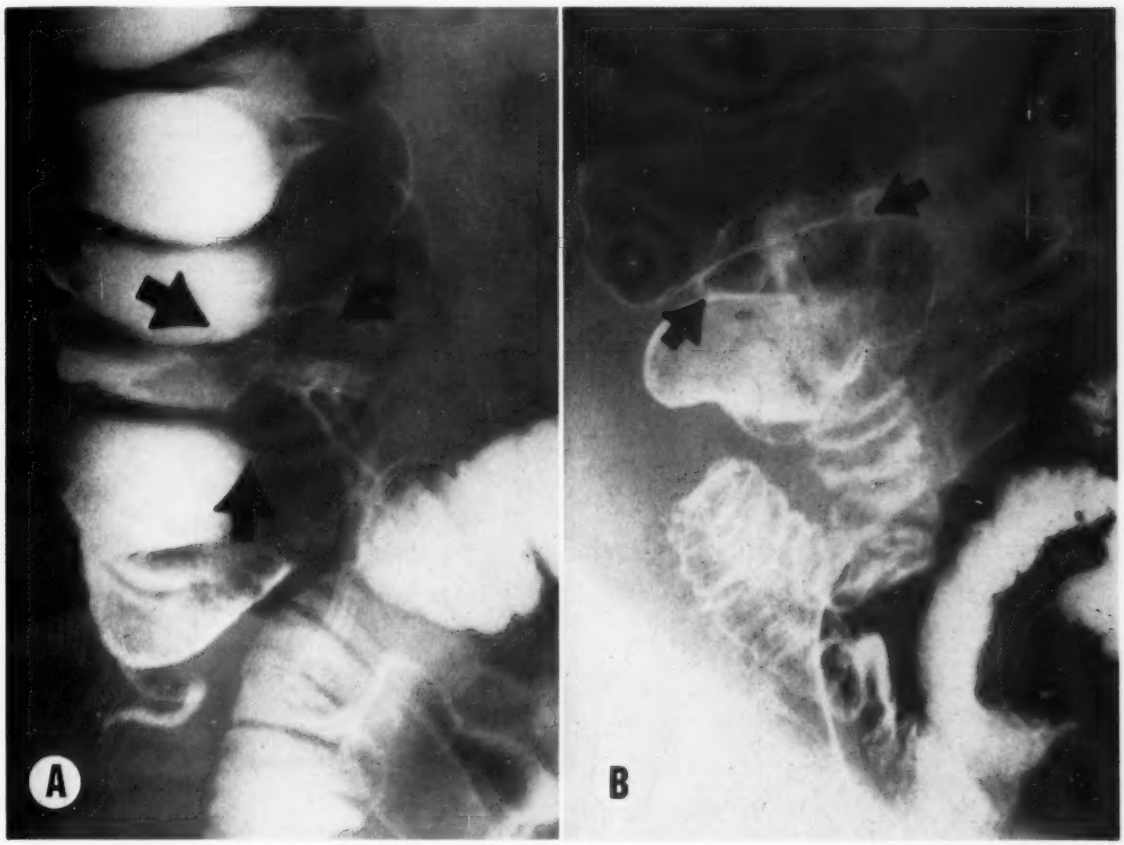

Fig. 5. Air contrast studies. (*A*) Roentgenogram: air contrast film of small but prominent posterior valve which simulates an intraluminal polyp on a pedicle. (*B*) Air contrast film of a larger defect. The ileum can be seen leading into the valve.

arising in the ileocecal valve lips proper is low.[2,8]

It is becoming increasingly evident that the ileocecal valve produces a filling defect in the cecum much more commonly than does ileocecal tumor. Tumors arising in the cecum but not actually on the lips of the valves should cause no confusion, as such filling defects can be separated from the lips, do not bear the typical central star, rosette or slit, and are not in continuity with the lumen of the terminal ileum. Small tumors are more apt to be simulated by invaginated appendiceal stumps[7] than by ileocecal valves.

When an unusual or asymmetrical filling defect is encountered, which cannot be absolutely identified with the upper or lower valve lip or cannot be proved conclusively to be the result of ileal mucosal herniation, surgical exploration is indicated, as neoplastic disease must be suspected. Surgery is mandatory in those patients having ileal prolapse together with blood in the stool, anemia or a palpable mass.

CASE PRESENTATION AND COMMENTS

General. Within the last three years we have found 23 large ileocecal valve defects ranging in size from 2.5 to 4.0 cm. in vertical dimension. In 21 of these we felt confident that the defect was the result of the valve itself or of ileal prolapse. There were no significant clinical or laboratory findings and no operative intervention seemed justifiable. These patients are still being followed roentgenologically.

Case 22 (in brief). In 1 case we found a prominent posterior ileocecal valve defect

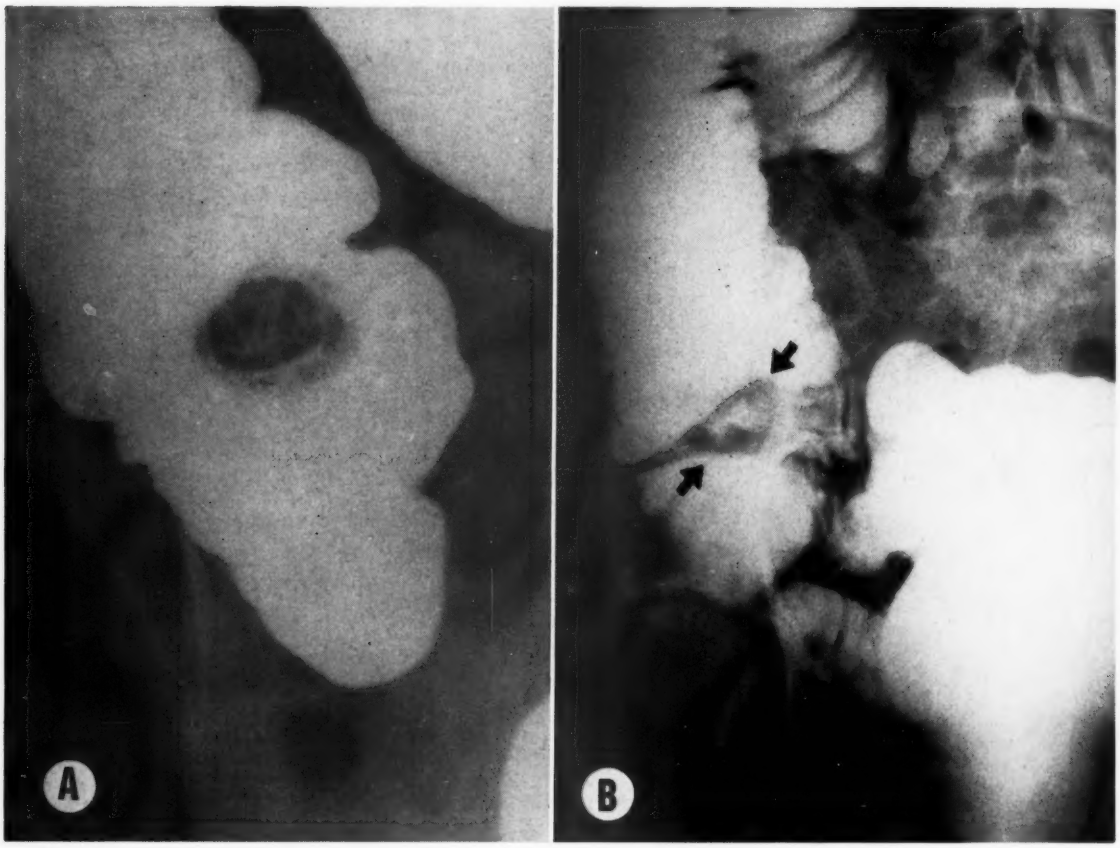

Fig. 6. Prolapse of ileal mucosa. (*A*) Pressure roentgenogram. Small prolapse. Here the defect is rounded, polypoid and granular. Whorls of mucosa are prominent. The central star or slit is replaced by ileal mucosa which protrudes into the cecum. (*B*) Roentgenogram of filled colon. Prominent defect produced by valve. The central slit-like valve orifice here stands out clearly and there is no masking by ileal proplase. This is a simple posteriorly situated valve.

associated with a palpable mass (Fig. 7*A*). This patient was operated upon and at exploration he was found to have adhesions about the cecum resulting from old inflammatory disease of the appendix. The ileocecal region appeared and felt entirely normal. The adhesions were released, the mass disappeared and postoperative barium enema examination disclosed again the typical ileocecal valve defect as shown in Figure 7*B*. The decisive factor leading to operation here was the presence of the mass rather than the ileocecal defect. It is interesting to find the latter unchanged after exploration and separation of the adhesions.

Case 23 (in more detail). Mrs. M. M. (No. 138–179). A fifty-seven year old housewife came to the diagnostic clinic complaining of arthritic pain in the fingers and knees and some fatigue.

Past medical history negative except for appendectomy. No gastrointestinal complaints.

Physical Examination. Obese white female showing evidence of mild arthritis of the fingers and knees. Blood pressure 160/110. Physical examination was otherwise entirely normal.

Laboratory Studies. Urinalysis negative. Serological studies negative. Blood count, November 25, 1949: Hg. 58 per cent; red blood cells, 3,090,000, with a normal differential; reticulocytes 3.4; hematocrit 21 per cent; icteric index 3; gastric analysis: Free hydrochloric acid in the fasting stomach 1 unit. Total acids reached a peak of 11 units.

Liver function studies: bromsulfalein test normal; thymol-turbidity normal.

Stool examination: negative for blood and parasites.

Course in Hospital. The patient was given

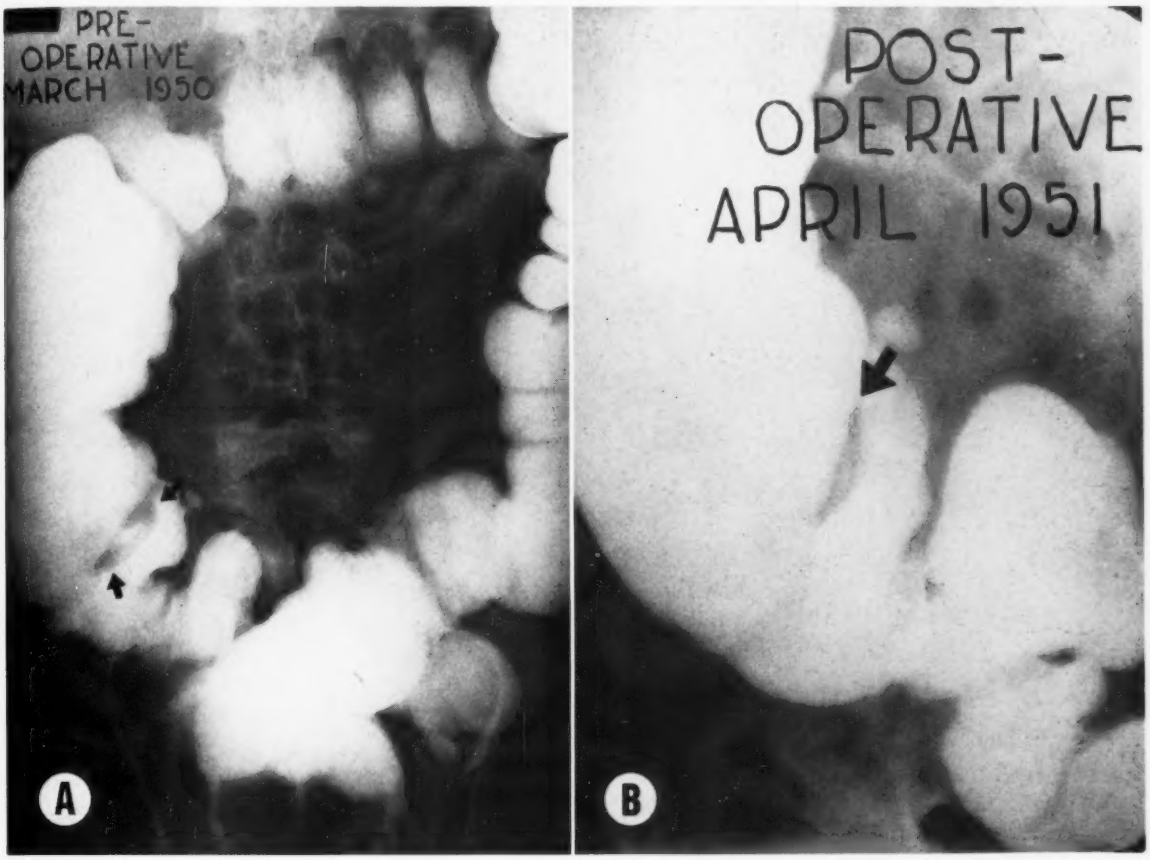

Fig. 7. Case 22. (*A*) Preoperative barium enema. The ileocecal defect is associated with a palpable mass. (*B*) Barium enema examination fourteen months after release of cecal adhesions. The valve defect remains unchanged.

multiple transfusions, and vitamin B_{12} intramuscularly, but no reticulocyte response occurred. A bone marrow biopsy disclosed a megaloblastic type of marrow, but a definite diagnosis of primary pernicious anemia could not be made.

Roentgenological Studies. Upper gastrointestinal study November 22, 1949. A hiatus hernia of the short esophagus type was found. The upper gastrointestinal tract appeared otherwise normal.

Barium enema examination, November 27, 1949. A 6 cm. filling defect was found in the cecum. This was situated on the posterior mesial wall of the cecum. The surfaces of the rounded, slightly lobulated filling defect appeared to be covered by intact mucosa of the ileal type. In the central portion of the large defect, a clear star-shaped orifice was delineated. Barium entered the terminal ileum and it appeared that this star-shaped structure was the site of the ileocecal valve (Fig. 8, *A* and *B*).

The barium enema examination was repeated on November 28, 1949, and the findings were reproduced. "We believe there is edema of the soft tissues about the ileocecal valve and probable herniation of the mucosa of the ileum into the cecum. Because of the large size of the defect and the severe edema we cannot exclude the possibility of tumor of the ileocecal valve."

Surgical Exploration. On December 7, 1949, a linear incision was made in the right lower quadrant and the cecum and the terminal ileum were explored. The cecum was mobilized in order to facilitate careful palpation. There were numerous adhesions about the cecum and the appendix had been removed previously. There was some thickening in the region of the ileocecal valve which felt soft and patulous. There was no tumor, hypertrophy of the ileo-

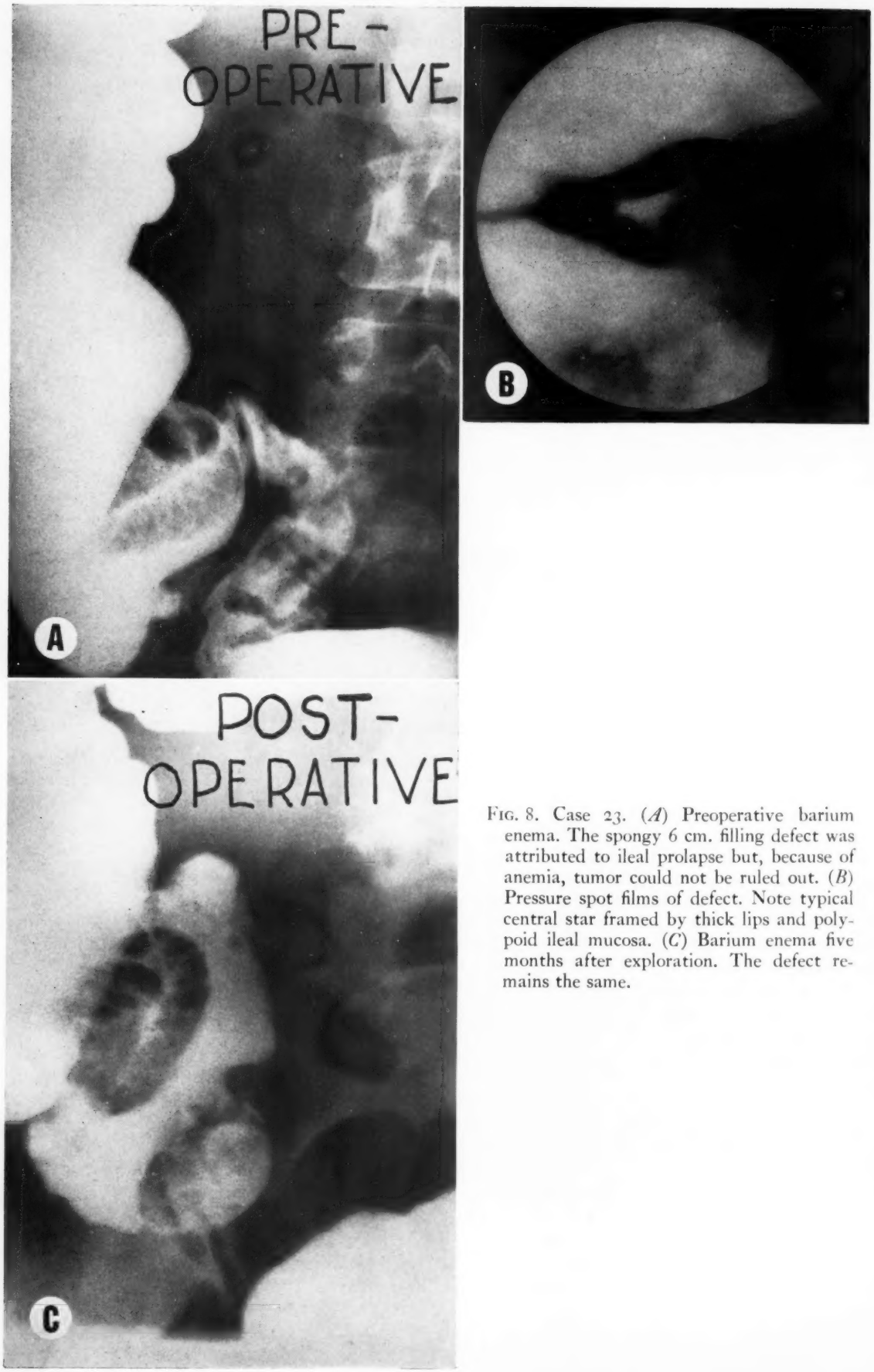

FIG. 8. Case 23. (*A*) Preoperative barium enema. The spongy 6 cm. filling defect was attributed to ileal prolapse but, because of anemia, tumor could not be ruled out. (*B*) Pressure spot films of defect. Note typical central star framed by thick lips and polypoid ileal mucosa. (*C*) Barium enema five months after exploration. The defect remains the same.

cecal valve or demonstrable invagination of the ileum into the cecum. The adhesions were separated and the abdomen was closed without drainage.

Following operation, the patient made an uneventful recovery, the blood count showed steady improvement and at the time of discharge the hemoglobin was 84 per cent, red blood cells 4,900,000, white blood cell count 11,000, with a normal differential.

The patient was asked to return to the Department of Radiology and on April 28, 1950, the barium enema examination was repeated at which time the large filling defect produced by the ileocecal valve and the pouting ileal mucosa was reproduced (Fig. 8*C*).

A small intestinal study was also done. This revealed no abnormality of the small intestine. The ileocecal valve defect was less clear cut and smaller (3 cm. in vertical dimension) on this examination than on the three previous barium enema studies.

Comment. The large cecal defect was almost certainly produced by edema and prolapse of ileal mucosa into the cecum. Perhaps the castor oil exaggerated the finding which was reproduced on three barium enema examinations and was much smaller when found on small intestinal study not preceded by catharsis.

Follow-Up. This patient has been followed roentgenologically for two years. The large ileocecal defect remains the same on barium enema examination, and is smaller but still present on barium study by mouth. She remains in excellent health and has had no recurrence of the anemia.

Discussion of Surgical Findings. In spite of the large defects encountered and reported by various authors,[3,4,5] the surgical findings have been surprisingly minimal. Palpation of the ileocecal valve region by the surgeon usually discloses nothing abnormal. In a few cases the cecum has been opened but even though there was gross prolapse of the ileal mucosa, no surgical repair has been undertaken, and in the light of present knowledge there is no justification for resection of an ileocecal valve simply because it is large or permits prolapse of the ileal mucosa.

It occurs to us that the surgeon may find little or nothing abnormal for several reasons, namely: (1) operation is not preceded by castor oil catharsis; (2) diet has been restricted before surgery; (3) there is often fecal material in the cecum; (4) the anesthetic decreases peristalsis and muscle tone allowing herniated mucosa to reduce itself; (5) in the process of mobilization and elevation of the cecum for visibility, the surgeon may exert enough traction to reduce the prolapse of soft mucosa which was responsible for the defect found by the radiologist on barium enema examination.

SUMMARY

The ileocecal valve can be and should be identified and evaluated in essentially every barium enema roentgen examination. This is readily accomplished when barium is introduced into the terminal ileum and graduated pressure is applied to the area.

The appearance of the filling defect at the valve orifice is dependent upon the site of implantation, the size, shape and thickness of the valve lips, and the degree of prolapse of ileal mucosa.

There is a wide range of normal variation with respect to size, location and prominence of such defects.

Several factors which tend to produce conspicuous defects are presented, together with two cases of presumable ileal prolapse, which were surgically explored.

It is our belief that preparatory catharsis exaggerates the filling defect produced by ileal prolapse.

Radiologists should not urge exploration in cases of conspicuous ileocecal valve defects of normal size, as the surgical findings are usually minimal or entirely negative. There is no evidence to indicate that large or patulous ileocecal valves should be resected.

Not all large or peculiarly shaped defects can be differentiated with certainty from tumor of the valve lips. In such cases, as well as in those clinically suspected of tumor, exploration is mandatory.

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ESOPHAGEAL PERFORATIONS*†

A REVIEW OF ETIOLOGY WITH REPRESENTATIVE CASE PRESENTATIONS

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THE radiological journals contain surprisingly few articles on esophageal perforations. The purpose of this report is to review the various etiological factors, together with a consideration of the clinical, pathological and roentgenological findings and present representative cases from the files of Lawson Veterans Administration Hospital.

Perforations and fistulae of the esophagus may be divided into congenital and acquired types. This report will be concerned with acquired perforations only. The various causes of esophageal perforations are found in Table 1 and will be considered in that order.

PRIMARY (SPONTANEOUS) PERFORATION OF THE ESOPHAGUS

Spontaneous perforation of the esophagus is the most serious of all esophageal perforations. The symptom complex has only recently been more widely recognized. Through March, 1950, there had been 91 cases reported in the literature,[18] of which 16 survived. No survival was recorded before 1944; 2 cases survived between 1944 and 1946, 14 cases surviving since 1947. Only 23 per cent of the cases were diagnosed antemortem before 1947; whereas, since 1947, 57 per cent have been accurately diagnosed. This is a tribute to better diagnostic facilities and knowledge of the clinical picture.

Mechanism of Rupture. Most authorities[13,14] agree that the essential factor in spontaneous perforation of the esophagus is a sudden increase in intra-adbominal pressure associated with spasm of the pylorus and cricopharyngeus muscles with resulting sudden increase in the intraluminal pressure of the lower esophagus. With these conditions present, there is a spontaneous tear in the distal end of the esophagus. Anatomical studies of Mosher[17] show that the distal end of the esophagus is inherently its weakest portion. He demonstrated histologically that the muscles in this area terminate in a conical fashion and are thinner, that there are segmental defects in the circular muscle coat, and that inherent weakness exists at the entrance of vessels and nerves into the distal esophagus. Experimentally, this is the point of ruputre when the esophagus of a cadaver is distended to its bursting point.[13]

Pathology. The tear in the esophagus involves all coats, occurs in the distal 3 inches, varies in size from a few millimeters to 9 cm., and assumes a longitudinal direction. With perforation there is immediate dissection of the stomach contents into the mediastinum and into the left, or rarely the right, pleural space. Air passes along the fascial planes of the mediastinum into the neck. Subcutaneous emphysema can be demonstrated in two-thirds of the cases, pleural fluid in 91 per cent.[18]

Associated Conditions. Cushing[6] in 1932 noted the frequent association of cerebral disease with perforations and ulceration in the gastrointestinal tract. The exact relationship has never been explained. Meningitis, cerebrospinal lues, epilepsy, hemorrhage, head injury, and poliomyelitis have all been associated with ruputre of the esophagus. Perforations have followed vomiting of pregnancy, seasickness, def-

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† Presented with slight modification before the Atlanta Radiological Society, at the Academy of Medicine, Atlanta, Georgia, on October 13, 1950.

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ecation, and during gastrointestinal series.[18]

Clinical Course. Characteristically, this condition occurs in middle-aged men, usually alcoholics, following vomiting or after a heavy meal. There is an acute onset with severe substernal pain which radiates to the back and is not relieved by opiates. The patient goes rapidly into shock. A perforated peptic ulcer is usually suspected and many cases have had an emergency laparotomy performed. There may be a history of cerebral disease or the onset may follow brain surgery.

Physical examination reveals an acutely ill patient in shock, with cyanosis, palpable subcutaneous air in the neck, and signs of left-sided effusion. Many cases, however, are not typical and the diagnosis is usually discovered many days later after valuable time has been lost. In these cases roentgenological findings may reveal the diagnosis early where clinical findings were not specific.

Roentgenographic Findings. Thirty-five of the reported cases have had roentgenological studies with the following salient features:[18]

1. Hydro(pneumo)thorax on left side occurs in about 50 per cent of the cases; the fluid is bilateral in one-fourth, and confined to the right side only in 7 per cent (see Fig. 1*a*).

2. Cervical and/or mediastinal emphysema has been demonstrated in 60 per cent of the cases reported. This appears as an area of increased radiolucency in the fascial planes of the neck and mediastinum (see Fig. 1*a* and Fig. 8*b*).

3. Mediastinal widening is occasionally

Table I

CAUSES OF ESOPHAGEAL PERFORATIONS AND FISTULAE

I. Congenital—atresia and broncho-esophageal fistula
II. Acquired
  (A) Primary (spontaneous) in "healthy" esophagus
  (B) Secondary
    1. due to trauma from within
      a. foreign body
      b. chemical burns
      c. instrumentation
    2. due to trauma from without
      a. abdominal crushing injury
      b. thoracic crushing injury
      c. penetrating wounds (stab, gunshot wounds)
    3. due to disease
      a. neoplasms
        (1) carcinoma of the esophagus
        (2) mediastinal metastases
        (3) Hodgkin's disease
        (4) bronchogenic carcinoma
        (5) thyroid carcinoma
        (6) laryngeal carcinoma
        (7) tracheal carcinoma
      b. inflammations
        (1) tuberculosis
        (2) syphilis
        (3) actinomycosis
        (4) empyema (pyogenic)
      c. peptic ulcer
      d. diverticula, pulsion and traction
      e. aneurysms (true and dissecting) perforating into esophagus
      f. postoperative breakdown of esophageal anastomoses

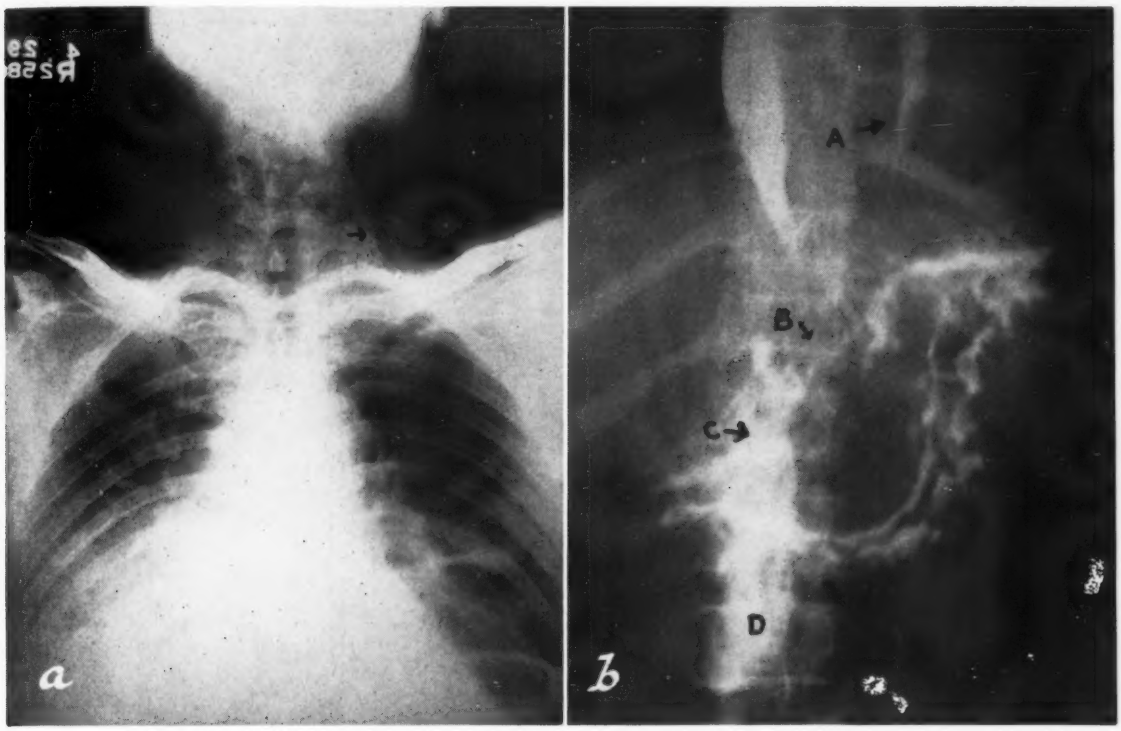

Fig. 1. Case 1. (*a*) Anteroposterior roentgenogram of chest. There is free air within the fascial planes of the neck with fluid at the right base due to spontaneous rupture of the distal esophagus. (*B*) Barium swallow ten days after onset of illness. There is a large mediastinal fistula (*A*) extending to the left of the esophagus arising just above the level of the diaphragm. There is a second fistulous tract (*B*) leading from the distal end of the esophagus to the anterior abdominal wall (*C*). Some barium is on anterior abdominal wall (*D*).

seen in later stages of the disease but rarely early.

4. Lipiodol swallow will demonstrate the site of perforation and indicate the relationship to the pleural spaces (see Fig. 1*b*).

5. The absence of subdiaphragmatic air is an important negative finding since no reported case has shown this finding. Free peritoneal air eliminates ruptured esophagus as a diagnostic possibility.

Differential Diagnosis.[4,13,18] Ruptured peptic ulcer is most often confused with spontaneous perforation of the esophagus. Other conditions to be differentiated are acute cholecystitis, pancreatitis, intestinal obstruction, perforated appendix, pulmonary infarction, coronary infarction, spontaneous pneumothorax, acute pleural effusions, and dissecting aneurysm.

Case 1. (Previously reported by Priviteri and Gay.[18])

A fifty-nine year old white male, on April 27, 1949, experienced sensation of food sticking in his throat. He voluntarily induced vomiting and immediately developed severe lower anterior chest pain. A diagnosis of acute surgical abdomen was made at another hospital and operation done which showed no abnormality. The next day, orally ingested orange juice drained through the abdominal incision. He developed shortness of breath and fluid at right base. A portable roentgenogram of the chest showed extensive cervical emphysema and right pleural effusion (Fig. 1*a*). Patient was treated with antibiotics and thoracenteses. His condition remained critical. Ten days later barium swallow demonstrated mediastinal fistula and also a fistula to the anterior abdominal wall (Fig. 1*b*). At Lawson Hospital a jejunostomy was done and antibiotics continued. Patient gradually improved during the following two months after which time an esophagram was entirely normal.

SECONDARY PERFORATIONS

1. *Due to trauma from within*

(a) *Foreign body*

The most frequent traumatic causes of esophageal perforation are foreign bodies and instrumentations.[23] Matheson[14] reviewed 602 cases of foreign bodies of the esophagus. Of these, 77 caused laceration, 2 with fatal termination. One was in the proximal esophagus with a large abscess developing after a denture had perforated the cervical esophagus; the other was after a mutton bone had perforated the lower esophagus with mediastinitis and right empyema. Hughes[11] reported a case of a child who swallowed a safety pin which perforated the lower esophagus with resulting pleural fistula and empyema with recovery after antibiotics. He could find only 3 similar cases in the literature, all fatal, in which a safety pin had perforated from the esophagus into a pleural space.

Perforations of the upper esophagus are most frequent with foreign bodies. They usually perforate at the pharyngo-esophageal junction, most often on the posterior wall, since this is a point of anatomic narrowing, and there is a natural weakness due to the absence of longitudinal muscle fibers at this level. However, Jemerin and Aronoff[12] reported 3 cases in which perforation was anterior with resulting thyroid abscesses. These perforations usually remain localized and only rarely does the infection spread into the superior mediastinum. Upper esophageal perforations offer the best prognosis.

Diagnosis is based on history of swallowing a foreign body, followed by dysphagia and pain in lower neck. Physical examination shows tenderness, redness, swelling of the lower neck, particularly if anterolateral perforation has occurred.

Roentgenologic signs establish the diagnosis:

1. Regional prevertebral swelling of soft tissues.

2. Air in retropharyngeal or retrotracheal space and rarely in the mediastinum.

3. Visualization of foreign bodies if opaque.

4. Lipiodol demonstration of fistula.

Perforations of lower esophagus are fortunately rare. Diagnosis is based on history of swallowing of a foreign body, followed by severe chest pain, fever, roentgenographic findings of cervical emphysema, pleural fluid, etc., as occurs with spontaneous perforation of the esophagus.

Case II. (This case is interesting in that the acute perforation was apparently minute and caused little difficulty, but the after-effects five years later caused considerable difficulty in diagnosis.)

A twenty-eight year old white male, in 1943, accidentally swallowed a small chicken bone. Following this, his esophagus was slightly irritated but caused no significant difficulty. In 1946 he began to have dysphagia, which gradually progressed until admission in November, 1948, when he could swallow only liquids.

Roentgenograms suggested mediastinal mass attached to the esophagus (Fig. 2*a*).

Operation revealed a dense fibrous periesophageal mass of scar tissue which had developed following the perforation by the chicken bone. This was resected and patient was cured (Fig. 2*b*).

(b) *Chemical burns*

Chemical burns of the esophagus are still unfortunately fairly common. Lye is by far the most common agent (64 per cent of the cases in Uhde's[22] series). Practically all strong acids and caustics have been reported in cases in the literature. Seventy-nine per cent of one series occurred under ten years of age.[22]

Symptoms. In severe cases obstruction with edema may occur in one week. There is frequently disturbance in the function of swallowing, so that aspiration pneumonia is common. In less severe cases after the acute phase of one to two weeks, there is an asymptomatic period followed by dysphagia four to six weeks later due to stricture.

Pathology. At twenty-four hours the mucosa is swollen, eroded, with gray exudate; it bleeds easily. In seven to four-

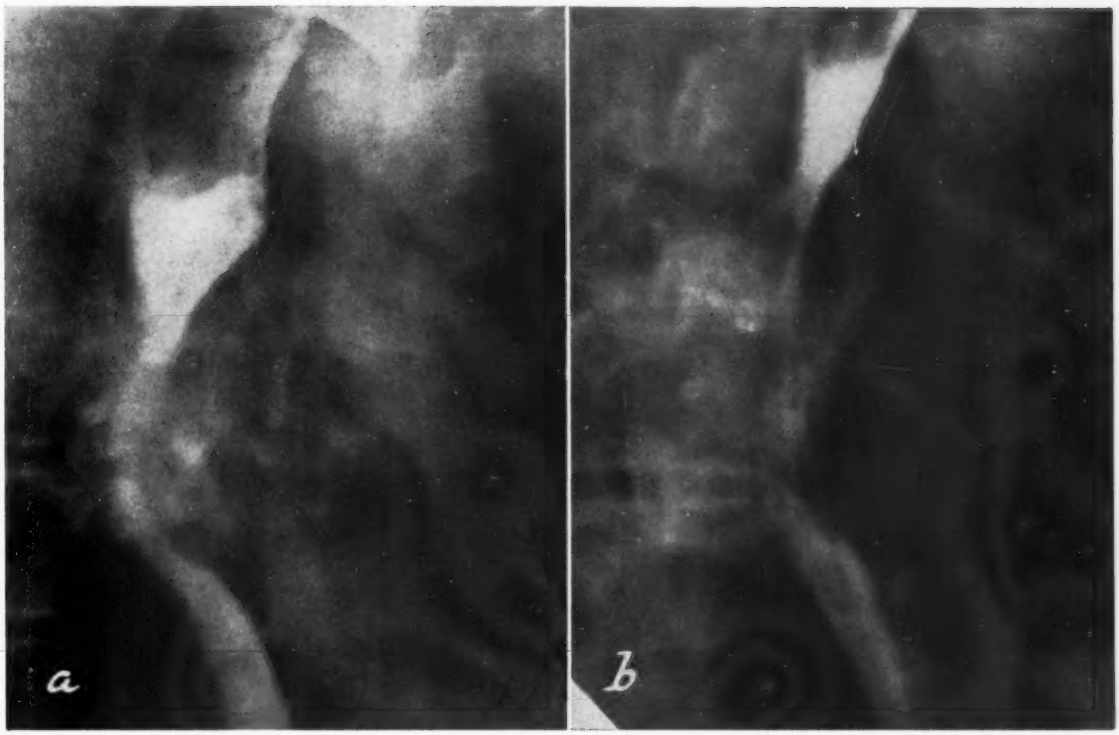

Fig. 2. Case II. (*a*) Esophagram. There is a mediastinal mass fixed to the anterior wall of the esophagus at the level of the middle third which suggests an intramural lesion. Operation revealed a dense fibrous mass attached to the wall of the esophagus which pathologically was scar tissue resulting from previous perforation of the esophagus by a chicken bone. (*b*) Postoperative esophagram showing little residual esophageal deformity and a normal mucosal pattern.

teen days, granulation tissue develops. At six weeks the burned areas are replaced by fibrous tissue. Strictures develop at points of anatomic narrowing. Sixty to 75 per cent of cases develop strictures, 5 per cent becoming impermeable.

Carbolic acid causes death from absorption from the stomach. If the patient recovers from toxic effects, stricture rarely develops. Acute erythema without stricture usually follows in cases of lysol, iodine, formaldehyde, hydrocholoric acid and chlorox burns.

Complications are dehydration, starvation, lung infections, hemorrhage, malignant degeneration, peri-esophagitis, mediastinal abscess, and esophageal perforation.

Perforations of the esophagus in chemical burns may be associated with one of the following conditions: (1) during treatment of complications and instrumentation (dilatation); (2) acute ulceration accompanying severe burns; (3) after impaction of food in stricture, with forced vomiting to dislodge impaction. Engler[7] reported a case of lye burn of the esophagus which resulted in esophagobronchial fistula which was demonstrated roentgenographically.

Diagnosis of perforation. In a patient with chemical burns the onset of intractable chest pain, high fever, shock, cyanosis, signs of pleural effusion, or pulmonary infection, should suggest perforation. A fistula may be demonstrated by lipiodol swallow. These patients frequently die in spite of all therapy.

Case III. A twenty-five year old colored male accidentally drank a half glass of lye thirty-six hours before admission. He vomited immediately and noted severe abdominal pain and burns in the mouth. He later coughed up blood in small amounts. He was taken to

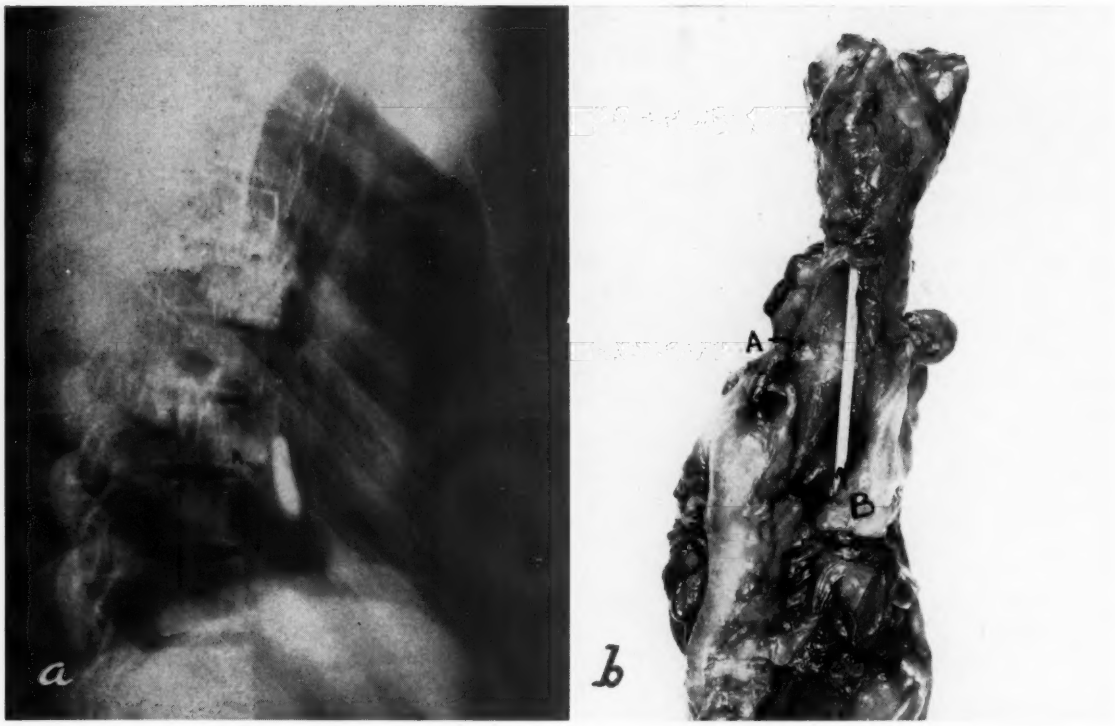

Fig. 3. Case III. (*a*) Lateral roentgenogram of chest after roentgenoscopy and lipiodol swallow. There is complete obstruction to the flow of lipiodol in the distal esophagus due to spasm and edema (*A*). Because of incoordination of pharyngeal muscles, there was regurgitation of oil into the superior division of the right lower lobe and posterior segment of the right upper lobe. No esophageal fistula could be demonstrated at this time

(*b*) Postmortem specimen. A portion of mediastinal contents seen from posteriorly. There is complete necrosis of the posterior wall of the esophagus (*A*) which was actually formed by the prevertebral fascia. A large fistulous communication is present between the anterior wall of the esophagus and the trachea at the carina (*B*). Etiology: lye burns of esophagus.

another hospital where antibiotics were given. At Lawson Hospital, a few hours later, physical examination showed rapid respiration, extensive stomatitis, and diffuse abdominal tenderness.

Roentgenograms and roentgenoscopy with lipiodol swallow demonstrated obstruction in distal third of the esophagus, no fistula, and extravasation of oil into the trachea because of incoordination of the pharyngeal muscles (Fig. 3*a*).

Patient did fairly well for ten days but developed then a sudden temperature to 103° F. and complained of severe substernal pain. He died two days later following a massive hemorrhage.

Autopsy (see Fig. 3*b*). Very little of the posterior wall of the esophagus remained. There was a large 2 by 5 cm. communication between the esophagus and the trachea. There was necrosis of the gastric wall as well. There was no pleural communication. There was a bilateral bronchopneumonia.

(c) *Instrumentation*

Perforations during dilatation of stricture, gastroscopy, or in esophagoscopic study of carcinoma are most frequently seen.[21] We have had one patient in whom perforation occurred during biopsy of the esophagus in the operating room. This was realized while the patient was on the table and an immediate resection was done. The patient survived the procedure but died slightly over a year later from metastases.

Roentgenographic signs are as discussed under spontaneous perforation and perforations with foreign body.

2. *Due to trauma from without*

(a) *Crushing injuries to chest and abdomen* have been reported with subsequent perforation of the esophagus.[4] The mechanism in abdominal trauma is similar to those cases who have suddenly increased abdominal pressure from other causes (vomiting, convulsions, defecation, etc.). Perforation following chest injuries is less easily explained, but probably is due to compression of the esophagus when filled with air during swallowing at moment of injury.

All of these cases show identical findings clinically and roentgenographically as do spontaneous perforations. Many cases are diagnosed only at autopsy. Perforations of the esophagus should be strongly considered in any severe crushing injury of the chest, abdomen, or head when there is noted a rapidly developing hydropneumothorax or where cervical or mediastinal air can be demonstrated. These cases are usually fatal.

Case iv. (Presented through the courtesy of Dr. Augusta Willis, Chief, Department of Radiology, Lawson Hospital.)

A twenty-seven year old white male was originally seen by Dr. Willis in Orangeburg, S. C. He was in an automobile accident on April 22, 1949, receiving multiple fractures of the sternum. Three days after admission he developed dysphagia and violent coughing spells immediately on swallowing fluids. A bronchoesophageal fistula was demonstrated by Dr. Willis by lipiodol studies (see Fig. 4). He was transferred to Columbia Veterans Administration Hospital and eventually explored but the fistula could not be demonstrated. After this the patient continued to have pneumonia and a second operation was done, at which time the fistula was demonstrated between the trachea and esophagus at the level of the carina. This was resected and the esophagus closed. The patient died about one week later from symptoms of mediastinitis and shock. No autopsy was obtained.

(b) *Penetrating chest wounds* may occasionally involve the esophagus. They are difficult to diagnose because the picture is clouded by lung, chest wall, and mediastinal injury. The only reliable diagnostic sign would be that of a fistula demonstrated by lipiodol swallow. Pleural fluid, mediastinal and cervical emphysema are unreliable signs because these injuries are almost always associated with lung involvement, and profound shock as seen with esophageal perforation accompanies any vascular injury in the mediastinum without esophageal involvement.

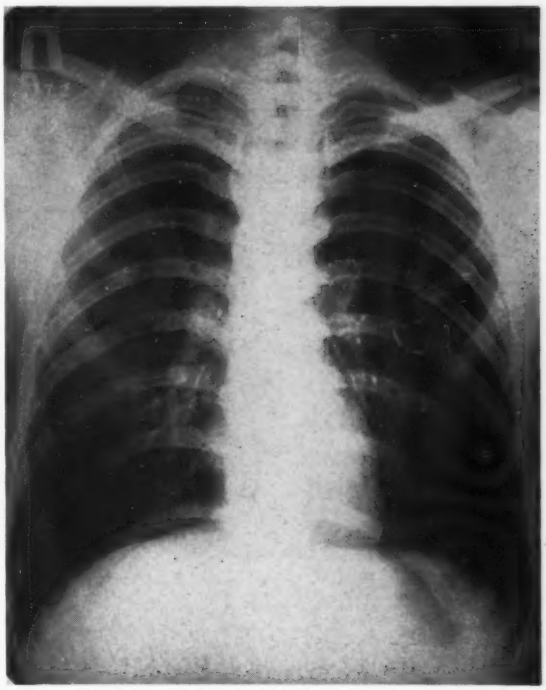

Fig. 4. Case iv. Posteroanterior roentgenogram of the chest after roentgenoscopy and lipiodol swallow. At roentgenoscopy there was noted extravasation of lipiodol from the esophagus into the trachea just above the carina. The immediate films revealed lipiodol within the bronchial tree due to post-traumatic esophagotracheal fistula.

3. *Due to disease*

(a) *Neoplasms* are the most common acquired cause of esophageal perforation.[1,16] Carcinoma of the esophagus is the most common neoplastic lesion causing esophageal fistulae; however, perforations of the esophagus have been reported accompanying many types of neoplasms, including carcinoma of the thyroid gland, bronchogenic carcinoma, Hodgkin's disease, car-

Fig. 5. Case v. Left anterior oblique roentgenogram of chest following lipiodol swallow demonstrates a large fistulous communication (*A*) between the esophagus and left main bronchus with extravasation of oil into left bronchial tree. Etiology was carcinoma of the esophagus.

cinoma of the larynx, carcinoma of the trachea, and mediastinal metastases from various sources.[1,16]

Carcinoma of the esophagus is highly fatal because of its relation to vital structures, the fact that the esophagus has no serosa, and that there are rich lymphatics in the submucosa and muscular coats. As a result of these factors, growth tends to spread longitudinally and to erode through the wall with subsequent fistula and mediastinitis. Taquino and Joseph[19] studied 145 cases with particular emphasis on metastasis and extensions of these tumors. Of their cases (studied at autopsy) 6 per cent perforated into the mediastinum, 3 per cent developed tracheo-esophageal fistula, and 8 per cent esophagobronchial fistula. A total of 25 cases (17 per cent) thus showed some type of esophageal perforation. Perforation of esophageal carcinoma may be directly into the aorta with fatal gastrointestinal hemorrhage.[3]

Vinson[23] points out that characteristically these patients do not get the acute symptoms that occur with other types of esophageal perforation. Because of the tumor and its secondarily infected ulcerations, there is inflammatory reaction in the mediastinum which tends to keep the infection localized for some time. The first sign on esophageal perforation may be that of pneumonia due to broncho-esophageal fistula. These perforations are usually subtle and accompany the terminal stages of the disease. Patients develop severe coughing attacks following oral fluids.

Case v. A fifty-seven year old white male developed progressive dysphagia eighteen months before admission. Esophagrams revealed carcinoma of the middle third of the esophagus. He was explored and found inoperable. Four weeks before death he developed a sudden chill and fever of 104° F. At this time he noticed that with every swallow of liquid he developed an attack of coughing. Lipiodol swallow revealed an esophagobronchial fistula (see Fig. 5). He died from pulmonary infection.

(b) *Inflammations*

Tuberculosis is by far the most common inflammatory lesion associated with esophageal perforation. Syphilis is an occasional cause.[9,16] Actinomycosis has been described by Vinson.[23]

Pathologically, tuberculous mediastinitis[10] develops from infected tracheobronchial lymph nodes and infrequently from rupture of a focus in the spine, pericardium or pleural cavity; it is a rare disease and is associated with active pulmonary tuberculosis most frequently. The lymph nodes enlarge, coalesce, and mediastinal abscesses form. There may be reactive adenitis with scarring rather than pus formation, resulting in adhesions about the trachea, bronchus, and esophagus. These may pull and stretch the esophagus or encircle it and cause stenosis. Large lymph nodes displace the esophagus. Infection may spread

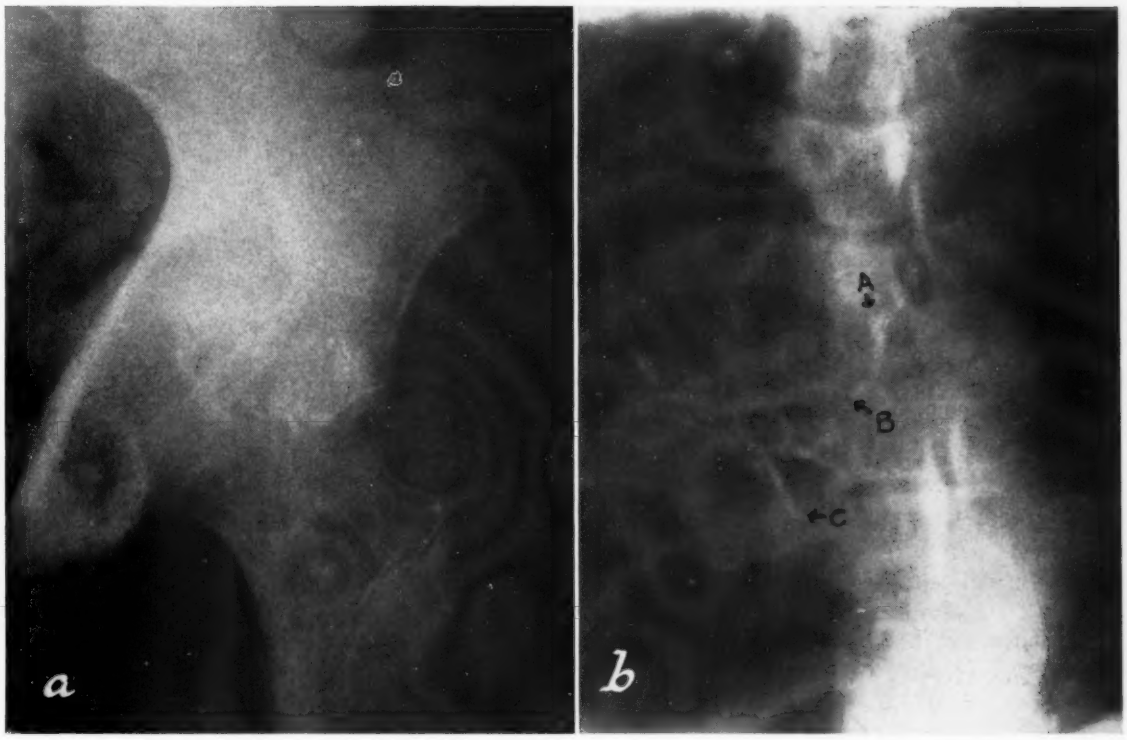

Fig. 6. Case vi. (*a*) Left hip. There is a destructive lesion of the joint involving superior aspect of the acetabulum and femoral head with almost complete obliteration of joint space. Culture of aspirated material proved a tuberculous etiology. (*b*) Spot film taken during roentgenoscopy and lipiodol swallow demonstrating traction diverticulum (*A*) of the esophagus from the apex of which extends a fistulous tract (*B*) into branches of the right bronchial tree (*C*).

into the esophagus with tubercle formation, ulceration, and eventual perforation. Seventy-three per cent of the cases of traction diverticula in a large series showed tuberculosis histopathologically.[7]

Roentgenographic signs. There are several changes in the esophagus associated with tuberculous mediastinitis. These have been recently emphasized by Hawes.[10] These include (1) displacement, (2) irregular mucosal pattern, (3) fistula from traction diverticula, (4) ulceration, (5) adherence of esophagus to the bronchus, producing an oblique cylindrical filling defect, (6) projections from esophageal lumen due to adhesions on outside wall; these are constant in contrast to peristalsic waves.

Case vi. A fifty-one year old colored male one year ago noted pain and stiffness in his left hip. This gradually became worse and after three months he was forced to use crutches and noted swelling around his left hip. He was hospitalized elsewhere and told he had arthritis. He returned home and symptoms progressed. During his illness he lost 35 pounds in weight. Physical examination on admission to Lawson Hospital showed a painful, swollen, indurated left hip, which was fixed to motion. No heat was noted. Three plus edema was seen in both legs. Remainder of examination was negative.

Roentgenograms of the left hip (Fig. 6*a*) showed a destructive lesion of the joint with involvement of the superior margin of the acetabulum and lateral aspect of the head of the femur with almost complete obliteration of the hip joint without any bone reaction. Findings were complicated by the presence of an oblique fracture of the middle third of the left femur; the patient denied any trauma which could have produced this. The roentgenographic findings in the left hip most closely resembled

tuberculosis. The fracture remained unexplained.

Hospital Course. The patient ran a daily temperature of 100–101° F. The pain in his left hip remained constant. Because of remote possibility of fracture of the left femoral shaft being pathological, various diagnostic procedures were carried out to find a primary neoplasm. A gastrointestinal series was included in the work-up. This gave definite evidence that we were dealing with a tuberculous process since a fistulous tract was demonstrated between a traction diverticulum of the esophagus and right bronchial tree (Fig. 6*b*). The patient oddly enough had no symptoms of this fistulous communication except that rarely after oral liquids he would cough; he had never had pneumonia.

A few days later pus was aspirated from the left hip which gave positive culture of the tubercle bacillus. The patient's family subsequently volunteered the information that he had fallen out of bed shortly before admission to the hospital, which explained his fractured femur.

Although this patient was never explored, it is reasonable to assume that the bronchoesophageal fistula was due to a mediastinal tuberculous process in view of positive culture from the left hip and presence of traction diverticulum in esophagus.

Pyogenic empyema. Empyema is a rare cause of esophageal perforation. Brewer[5] in 1946 could find only 17 cases due to pyogenic empyema which perforated into the esophagus. The diagnosis was made by the onset of increased toxicity, recovery of orally ingested material from thoracotomy tube, and vomiting of pus. Perforation in these cases is frequently related to episodes of vomiting.

Pathology. The empyema causes necrosis of the mediastinal pleura with dissection into the mediastinum and because of the lack of a serosa of the esophageal wall this is easily invaded. Tuberculous empyema is more commonly associated with

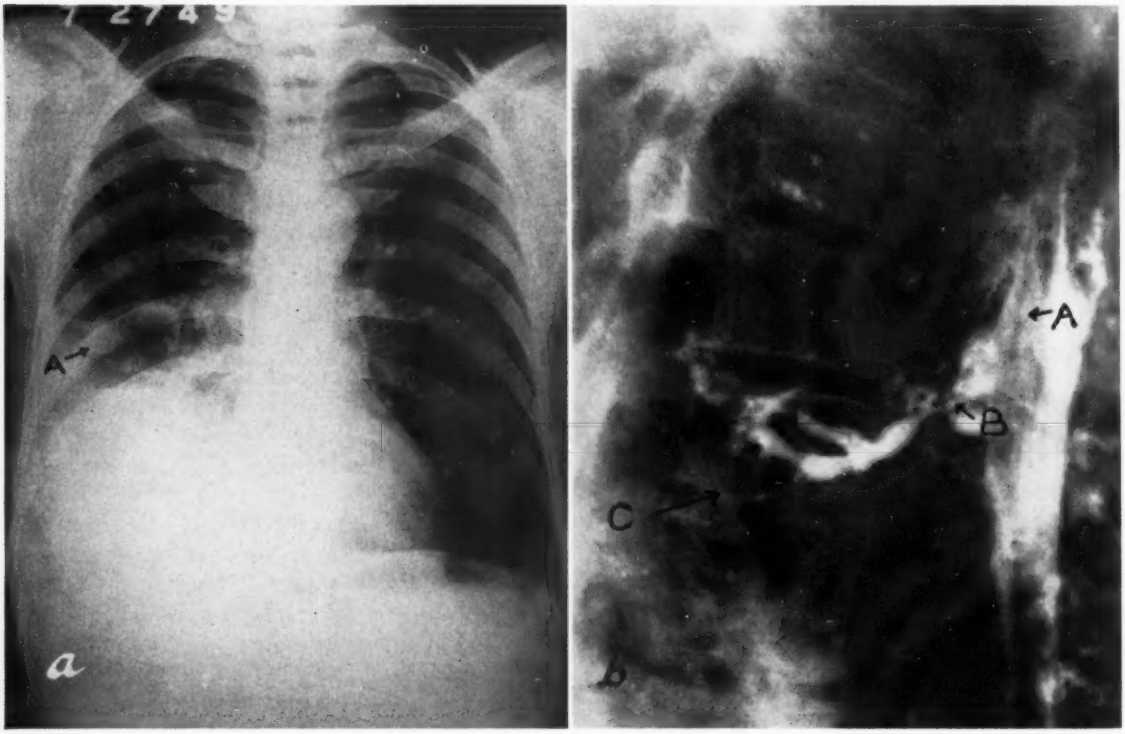

Fig. 7. Case vii. (*a*) Posteroanterior roentgenogram of the chest. There is fluid at right base. The air filled cavity (*A*) is due to loculated interlobar empyema with bronchopleural fistula. There is an underlying suppurative pneumonitis right lower lobe. (*b*) Spot film taken during roentgenoscopy and lipiodol swallow showing a fistulous tract (*B*) leading from the esophagus (*A*) to the superior division of the right lower lobe (*C*).

fistula than pyogenic empyema. The causative organisms usually involved are the staphylococcus, streptococcus, pneumococcus and actinomyces.

Case vii. A thirty-eight year old colored man, six days before admission, developed right pleuritic pain, fever, and severe cough. On admission he was cronically ill with signs of fluid at the right base. Roentgenograms revealed a suppurative pneumonitis of the right lower lobe with empyema (Fig. 7*a*). A bronchopleural fistula was demonstrated nine days later by injection of methylene blue into the right pleural space. He improved on antibiotics, but two months later developed reactivation of his pneumonia. Bronchograms revealed extensive bronchiectasis in the right middle and lower lobes. A few days later a broncho-esophageal fistula was demonstrated by lipiodol (Fig. 7*b*). The patient had no dysphagia. Operation revealed a fistulous tract from the esophagus communicating with the superior division of the right lower lobe. This was resected along with the lower and middle lobes.

Pathological diagnosis was chronic bronchiectasis with abscess and empyema and secondary broncho-esophageal fistula. No evidence was found of tuberculosis.

(c) *Peptic ulcer* occurs in the lower third of the esophagus usually and is related to the presence of aberrant gastric mucosa in the lower esophagus.[2] The incidence of perforation of the esophagus by peptic ulcer is not accurately known. In one autopsy series of Tileston[20] consisting of 40 cases, 14 per cent perforated with resulting fatality. Some authors feel that this incidence is high, considering the average group of cases. No perforations were reported in 13 cases of Friedenwald, Feldman and Zinn.[8] The incidence of perforation certainly depends on how early the diagnosis is made and how adequately the patient is treated.

Roentgenographic findings and symptoms are the same as for spontaneous perforations.

(d) *Diverticula*

Perforation of both traction and pulsion types of diverticula have been reported.[1,15,16] The actual immediate cause of the perforation in these cases is either associated inflammatory change (diverticulitis) or instrumentation. Tuberculosis is by far the most common cause of traction diverticula.[10] There are cases of perforation of traction diverticula reported, however, which show no histopathologic evidence of tuberculosis at postmortem.[15,16] Abbott[1] has reported a case of perforation in a pulsion diverticulum of the distal third of the esophagus two months after a plastic operation anastomosing the stomach with the large 12 cm. diverticulum.

The following case (presented through the courtesy of Dr. William W. Bryan, Consultant in Radiology, Lawson Veterans Administration Hospital) represents a perforation of a Zenker's diverticulum of the esophagus secondary to diverticulitis.

Case viii. A white female, aged sixty-five, was referred to Dr. Bryan for an esophagram with a history of dysphagia and pain in lower pharynx of several days' duration. She was known to have had Zenker's diverticulum for several years. Esophagram (Fig. 8*a*) revealed the small Zenker's diverticulum of the esophagus at the level of the fifth cervical interspace. There was associated soft tissue swelling around the diverticulum. This swelling compressed the trachea. There was irritability of the diverticulum.

Four days later the patient developed palpable cervical emphysema, dyspnea, and was acutely ill (Fig. 8*b*). Chest roentgenograms showed cervical and mediastinal emphysema. She was operated on elsewhere and the perforation repaired. The patient recovered.

(e) *True aneurysms and dissecting aneurysms of the aorta* may rupture into the esophagus. Bagnuolo and Bennett[3] have recently reviewed the literature and found 111 cases of non-traumatic perforations of the aorta into the gastrointestinal tract. Of this group only 1 case was noted of perforation of an aortic aneurysm into the lower third of the esophagus, whereas 45 cases of abdominal aneurysms ruptured into the gastrointestinal tract intra-abdominally, most commonly into the third portion of the duodenum. Carcinoma of the

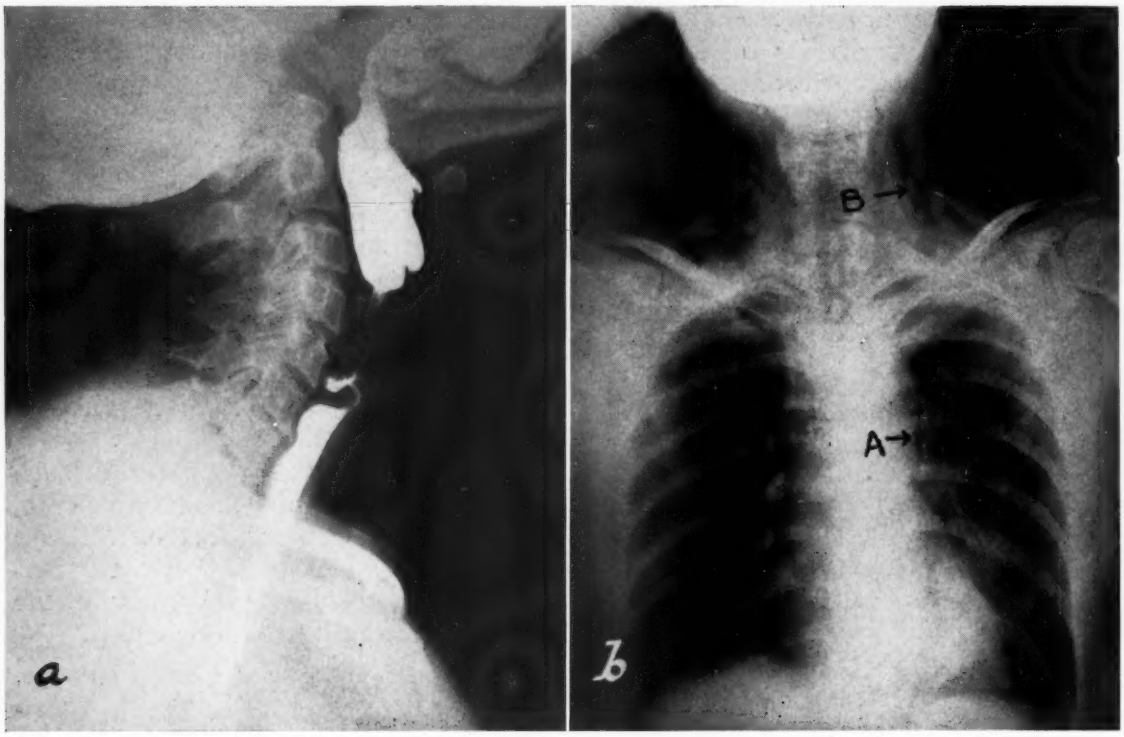

Fig 8. Case viii. (*a*) Esophagram. A small Zenker's diverticulum at the level of the fifth cervical interspace Note retropharyngeal soft tissue swelling compressing trachea in region of diverticulum with irregularity of the superior diverticular wall due to inflammatory changes.

(*b*) Posteroanterior chest roentgenogram after perforation of Zenker's diverticulum due to nonspecific inflammatory changes (diverticulitis). Note extensive mediastinal (*A*) and cervical emphysema (*B*). No pleural fluid is seen.

esophagus is by far the most common etiologic factor in perforations of the aorta into the esophagus (60 of 111 cases in Bagnuolo and Bennett's[3] series).

Perforation of the aorta into the esophagus will produce signs of shock with massive hematemesis and rapid death; however, some patients may live for several days, allowing the possibility of clinical diagnosis.[3] In any patient with signs of thoracic aneurysm or dissecting aneurysm in which there is associated hemorrhage from the gastrointestinal tract, perforation of the aorta into the esophagus should be considered.

Case ix. A thirty-seven year old white male farmer three weeks before admission developed chills and fever and tenderness of the calf. At another hospital a diagnosis of thrombophlebitis was made and response to penicillin therapy was immediate. After a few days he returned home. Five days before admission he developed sudden, severe substernal pain. Past history revealed that he had been discharged from the Army for hypertension. Examination on admission revealed the patient to be acutely ill, with a blood pressure of 220/120, and a palpable spleen. Laboratory examination showed red blood cells and albumin in the urine.

An anteroposterior roentgenogram of the chest (portable) (Fig. 9*a*) revealed marked notching of the ribs, a wide mediastinum, and prominence of the left ventricle.

The day after admission he began vomiting blood and complained of "food sticking" in his esophagus. He died the following day of a massive gastrointestinal hemorrhage.

Autopsy revealed (Fig. 9*b*) a coarctation of the aorta just distal to the left subclavian artery, subacute bacterial aortitis, a dissecting aneurysm of the proximal aorta, perforation of the aorta just distal to the coarctation at site of a vegetation with rupture directly into the esophagus. Mediastinitis was present.

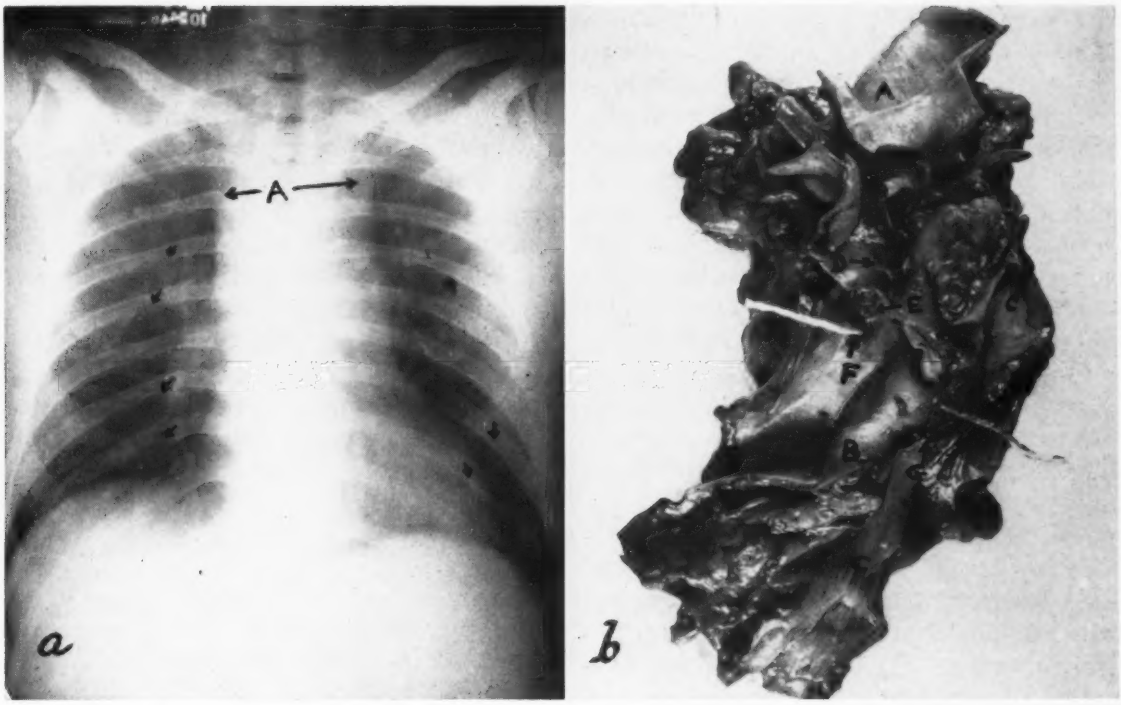

Fig. 9. Case ix. (*a*) Anteroposterior roentgenogram of chest (portable). There is marked widening of the superior mediastinum (*A*). There is minimal prominence of the left ventricular border. There is marked notching of the posterior ribs in the mid-dorsal area. Diagnosis: coarctation of aorta with subacute bacterial aortitis and dissecting aneurysm which perforated into esophagus.

(*b*) Autopsy specimen showing aorta (arch, *A*, and descending, *B*, portions) and esophagus (*C*). Aorta is opened. Note site of coarctation (*D*) and vegetations just distally on the aortic wall (*E*). A wire extends through the fistulous tract leading from the aorta (*F*) to the esophagus (*G*) where a hematoma is seen. Esophagus is opened. Note normal mucosal pattern (*C*).

Roentgenoscopic examination of an acutely ill patient suspected of having an esophageal perforation is difficult. Iodized oil is the medium of choice because of its non-toxic effect in the respiratory tract or mediastinum should extravasation occur. In several cases we have obtained better visualization of the fistulous tract with iodized oil than with thin barium solution, both media having been used at different times in the same patient. The desired careful examination roentgenoscopically of an acutely ill patient is frequently impossible. A negative esophagram does not always rule out an esophageal perforation. This fact was recently impressed upon us while I was affiliated with Grady Memorial Hospital, Atlanta, Georgia. An elderly colored male was examined with barium swallow roentgenoscopically. Marked spasm in the distal end of the esophagus was noted. On one immediate roentgenogram a faint line of barium was seen outside the confines of the esophagus just above the diaphragm; the constricted distal esophagus was again noted as was a slight irregularity in the mucosal pattern in that region. A repeat examination the following day with iodized oil again revealed the spasm distally in the esophagus. After about five minutes of examination with patient being manipulated in all possible positions, a small fistulous tract was demonstrated passing from the distal esophagus into the mediastinum; the mucosal deformity was again noted and was constant. A diagnosis of carcinoma of the esophagus with mediastinal fistula was made. This diagnosis was confirmed a few days later at postmortem examination.

A second case at Grady Hospital, seen a few days after the above-mentioned one, was that of a middle-aged male with a typical clinical history of spontaneous rupture of the esophagus. A chest roentgenogram revealed a tension hydropneumothorax on the left side but no mediastinal emphysema. The diagnosis was strongly suspected but could not be confirmed by a competent roentgenoscopist after iodized oil studies of the esophagus. A repeat examination a few days later demonstrated an esophagopleural fistula on the left side.

The above-mentioned cases serve to emphasize the difficulty of demonstration of esophageal fistula in some patients. *A negative esophagram should not rule out the possibility of esophageal perforation* in a patient with suggestive clinical signs. Repeated examinations are occasionally necessary to demonstrate the fistulous tract. Non-visualization of the fistula may be due to temporary occlusion of the tract by spasm (due to secondary inflammatory changes), blood clots, food particles, and cellular debris, or by failure to put the orifice of the fistula in a dependent position. The patient should be examined in prone, supine, and both lateral positions and repeated spot roentgenograms during roentgenoscopy taken.

SUMMARY

(1) Esophageal perforation from any cause is a serious accident.

(2) The various causes of esophageal perforation have been reviewed and representative cases presented.

(3) Only in the past three years has the accuracy of diagnosis of spontaneous rupture of the esophagus been improved. Since 1944 the mortality rate has been lowered by early diagnosis, followed by early operation. The radiologist should be familiar with the clinical picture and roentgenographic findings in order to make diagnosis early.

(4) In perforation of the upper esophagus the following roentgenographic signs are noted: (a) prevertebral soft tissue swelling, (b) foreign body if present, (c) free retrotracheal and retropharyngeal air, (d) fistula demonstrated by lipiodol swallow.

(5) In perforations of the lower esophagus the following roentgenographic signs are noted: (a) cervical or mediastinal emphysema, (b) hydropneumothorax, most frequently on left side, (c) mediastinal widening, (d) demonstration of perforation by lipiodol swallow.

(6) A negative esophagram should not exclude the possibility of esophageal perforation in the presence of suggestive clinical findings. Repeated examinations may be necessary to demonstrate the fistulous tract.

Grateful acknowledgment is given to Dr. William W. Bryan, Consultant in Radiology, Lawson Veterans Administration Hospital; Dr. Augusta Willis, Chief, Department of Radiology, Lawson Veterans Administration Hospital; and Dr. H. S. Weens, Chief, Department of Roentgenology, Grady Memorial Hospital, Atlanta, for use of cases mentioned or presented in this paper.

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INTUSSUSCEPTION (COLOCOLIC) WITH SPONTANEOUS EXTRUSION OF THE INTUSSUSCEPTUM

A CASE WITH UNUSUAL ROENTGEN MANIFESTATIONS

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INTUSSUSCEPTION followed by spontaneous sequestration and elimination of the intussusceptum, auto-anastomosis and recovery is a rare sequence of events in the present-day practice of medicine. Usually the diagnosis of intussusception is established readily by either clinical or roentgenologic means, and surgical intervention follows rapidly. When, however, the intussusception is unrecognized, or is marked by complications, sufficient time may elapse to permit the separation and expulsion of the gangrenous intussusceptum.

To our knowledge, only 6 such cases have been reported since 1894.[1,2,8,9,11,12] Four of these involved the ileum and 2 involved the colon.[11,12] Because of its extreme rarity, and unusual roentgen manifestations, a case of colocolic intussusception, followed by spontaneous elimination of the sequestrated intussusceptum and recovery, is added to the literature.

When laparotomy was a more formidable procedure than at present, spontaneous elimination of an intussusceptum was not infrequent. In 1862, Hearne[5] reported the case of a forty-one year old female who, fourteen days after the onset of abdominal pain, passed $6\frac{1}{2}$ inches of ileum per anus. She died of tuberculosis three months later. At autopsy, all that could be seen was a little thinning of the bowel and contraction at the point of union. Leichtenstern,[6] in 1873, collected from the literature 593 cases of intussusception, and reported that 42 per cent of these cases underwent spontaneous elimination. In a monograph on intussusception in 1877, Leichtenstern[7] stated that, "Sometimes the separation of the gangrenous intussusceptum takes place very gradually in small shreds, sometimes so insensibly that the process entirely escapes the notice of the patient. Sometimes a larger part of the intussusceptum is evacuated, or even the whole invaginated double cylinder (having separated at the neck), and its inner tube may be so well-preserved that it is possible to determine the exact seat of the invagination. The length of the separated piece varies from a few inches to three meters." In the majority of cases, separation took place from the eleventh to the twenty-first day after the onset but in some of the chronic cases did not occur for several months. He reported 1 case of intussusception of eleven months' duration and knew of others lasting one to four years. Separation, he stated, was most frequent in the ileum. It was rare in children under the age of two as they usually died before it could occur.

O'Connor,[9] in 1894, reported the passage of $11\frac{1}{4}$ inches of ileum with a Meckel's diverticulum by a thirteen year old boy, four days after the onset of abdominal pain. Also in 1894, Sutcliffe[12] reported the case of a seventeen year old boy who passed 13 inches of large bowel on the seventeenth day of his illness. Both of these patients recovered. Walton,[15] in 1911, stated that spontaneous separation of an intussusception was extremely rare and that it had occurred only once in his series of 239 cases. This case was reported separately by Sherren.[11] The patient who passed two pieces of transverse colon measuring $18\frac{1}{2}$ and $3\frac{1}{2}$ inches recovered but developed a stricture at the site of anastomosis. Fitzwilliams[4] in 1908, reviewing 1,000 cases of intussusception, found none who had spon-

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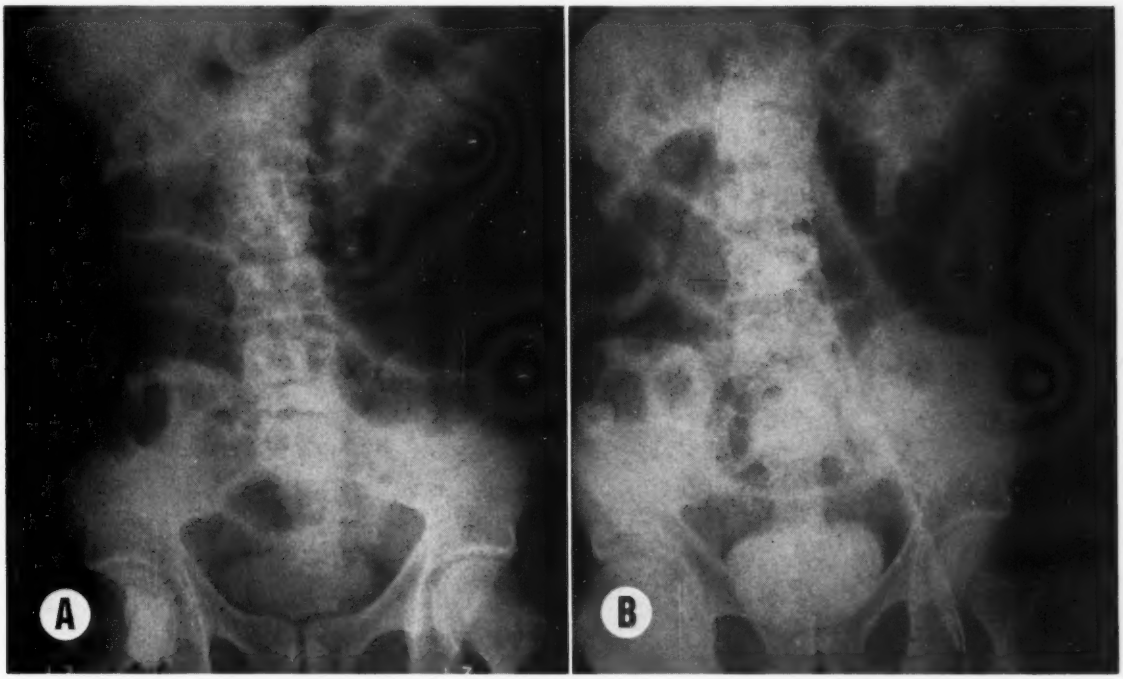

Fig. 1. Abdominal venography demonstrating thrombosis of the right iliac vein and inferior vena cava. (*A*) Complete obstruction of the right external iliac vein. (*B*) The inferior vena cava is not visualized, the contrast medium flowing instead into a prominent paravertebral plexus.

taneous elimination of the intussusceptum. Perrin and Lindsay[10] in 1921 published a monograph based on 400 cases in which no patient passed sequestrated bowel. They were skeptical of Leichtenstern's report that 42 per cent of all intussusceptions underwent this process, even in 1873 when laparotomy was uncommon. Single cases of spontaneous passage of intussuscepted ileum were reported by Mayo[8] in 1932, Bockoven[1] in 1936, and Finestone[3] in 1947.

CASE REPORT

J. G., Caucasian male, aged forty-nine, was first admitted to the Los Angeles County Hospital on August 4, 1942, complaining of severe pain and swelling of the right lower leg. This developed several days after the onset of an upper respiratory infection and sore throat. The findings on physical examination were those of a deep iliofemoral and superficial lesser saphenous thrombophlebitis. This progressed so that a large portion of the skin over the lateral and posterior aspects of the right thigh became gangrenous. During the next few months the resulting ulcer healed slowly but incompletely. As a result, the patient had chronic stasis dermatitis of both legs with recurrent superficial ulcerations necessitating re-admission to the hospital in 1945.

On August 15, 1948, after a large evening meal, the patient developed mild, intermittent, lower abdominal pain which was accompanied by nausea and retching. Several hours after the onset of pain he had several loose, bloody bowel movements. During the following two days the pain became less colicky and was most marked in the left lower quadrant of the abdomen. He continued to pass bloody stools. At this time he developed very severe pain in the anal region and entered the hospital August 17, 1948.

Examination on entry revealed a pale, acutely ill, white male with old, healed, stasis dermatitis of both legs and moderately increased vascular markings over the chest and abdomen. The abdomen was distended and tender, but not rigid. No organs or masses were palpable. Peristalsis was infrequent, but otherwise normal. The temperature was 100° F., pulse 120, respirations 20, and blood pressure 182/120. Urinalysis showed a trace of albumin and numerous red blood cells. The hemoglobin was 10.0 grams. Proctoscopic and sigmoidoscopic exami-

Fig. 2. Abdominal venography repeated after an interval of two and one-half months. The inferior vena cava is no longer obstructed. A large portion of the contrast medium passes into dilated, tortuous, pelvic veins and the paravertebral plexus. The common iliac vein has a striated appearance, suggesting multiple vascular channels extending through a partially recanalized thrombus.

nations the following day revealed very large, slightly tender, thrombosed, internal hemorrhoids and numerous large, dilated, tortuous veins extending along the bowel wall to the 6 inch level. Beyond this point, the bowel could not be visualized due to the presence of dark, foul, bloody, liquid feces. The urine was now grossly bloody. A diagnostic abdominal paracentesis on August 19, 1948, yielded thin, bloody fluid which did not clot on standing. The abdomen at this time was rigid, silent, and tender throughout. The patient was passing some gas per rectum.

Roentgenograms of the abdomen on August 20, 1948, revealed considerable ileus of the small intestine and some free intraperitoneal fluid. No masses or other significant abnormalities could be identified. In spite of the absence of marked venous distention and peripheral edema, it was felt that the patient might have a thrombosis of the inferior vena cava because of the gross blood in the urine, the abdominal cavity, and the bowel, and the history of a previous thrombophlebitis.

Using the technique described by Fariñas,[2] 40 cc. of 35 per cent neo-iopax was injected into both femoral veins through a 16 gauge needle. There was complete obstruction of the right iliac vein (Fig. 1*A*). The left iliac vein was patent, with the contrast medium passing into a prominent left paravertebral plexus (Fig. 1*B*). None was seen to enter the vena cava. Because of the hematuria, it was concluded that the thrombosis of the inferior vena cava extended above the insertion of the renal vein and that surgery was not advisable. The patient was given intravenous fluids and was heparinized. The vena caval obstruction was demonstrated again on August 23, 1948.

By August 23, 1948, the patient's urine was free of erythrocytes. The abdomen was flat and soft and he had had two bowel movements that were free of gross or occult blood. After subsidence of the abdominal distention, a firm mass could be palpated in the left lower quadrant of the abdomen. At no time had the small intestinal contents, obtained by means of an intestinal suction tube, contained blood.

On August 26, 1948 the patient was sigmoidoscoped. The previously visualized large hemorrhoids and tortuous vessels were no longer evident. The sigmoidoscope could not be passed above the 6 inch level. A barium enema showed an irregular constriction at the rectosigmoid junction. Above this constriction the barium entered into what was interpreted as an incompletely filled sigmoid loop and flowed freely into the descending and transverse colons (Fig. 3*A*). The "sigmoid loop" was surrounded by a large pocket of air which contained a small amount of barium. This was thought to represent perforation of the bowel, probably due to carcinoma, with a large surrounding air-containing abscess. A transverse colostomy was performed August 27, 1948. There was evidence of old peritonitis, with the omentum adherent in the left lower quadrant of the abdomen and in the pelvis. On attempting to free the omentum, approximately 25 to 30 cc. of pus was encountered. No further exploration was attempted.

The postoperative course was relatively uneventful. However, the patient frequently complained of a bearing-down sensation as though he had to move his bowels. On September 16, 1948, twenty-two days after the onset of symptoms, he expelled 23 inches of large bowel, all the layers of which were necrotic. Examination of this specimen showed no evidence of an associated tumor (Fig. 4). At this time the barium

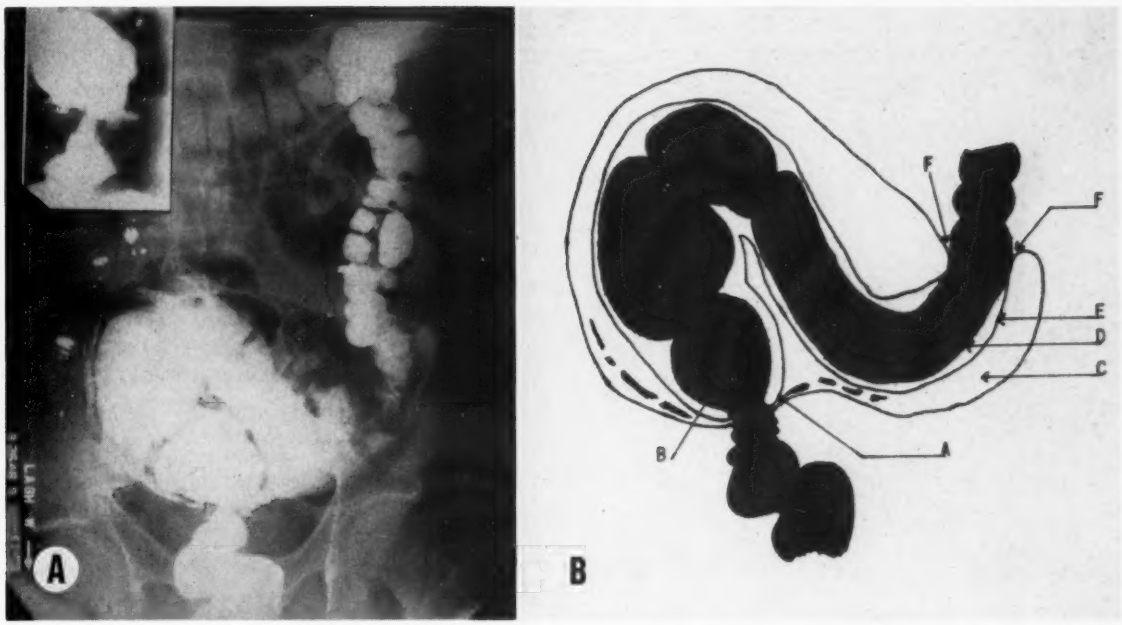

Fig. 3. (*A*) Barium enema five days after onset of symptoms shows a continuous column of barium extending from rectosigmoid into a patent intussusceptum (descending colon). This is surrounded by an air-filled intussuscipiens into which a small amount of barium has escaped. *Inset.* Spot roentgenogram of junction of rectosigmoid and tip of intussusceptum showing uninterrupted column of barium and irregular constriction of the sigmoid simulating carcinoma. (*B*) Explanatory diagram of (*A*). (A) Tip of intussusceptum which has advanced to relatively fixed margin of intussuscipiens. (B) Barium-filled patent intussusceptum. (C) Air-filled intussuscipiens containing small amount of barium. (D) Serosal surface of intussusceptum. (E) Serosal surface of intussuscipiens. (F) Neck of intussusception where D and E have become adherent, permitting sequestration of intussusceptum and aut -anastomosis.

enema examination of August 26, 1948, was reviewed (Fig. 3*B*). It was evident that what had been interpreted as an abscess surrounding the sigmoid was, in fact, a colocolic intussusception in which the barium had passed in an uninterrrupted column into the intussusceptum, the lumen of which was not completely occluded, and from there into the proximal colon. The air pocket was the dilated lumen of the intussuscipiens into which a small amount of barium had escaped. Following the passage of the sequestrated intussusceptum, the patient continued to improve.

Abdominal venography was repeated on November 4, 1948, neo-iopax being injected into the left femoral vein. The inferior vena cava was no longer obstructed. A large portion of the contrast medium passed into the left paravertebral plexus and into tortuous, dilated, pelvic veins. The left common iliac vein had a striated appearance suggesting multiple vascular channels extending through a partially recanalized thrombus (Fig. 2).

A barium enema on November 16, 1948, showed an area of marked constriction, approximately 8 cm. in length, between the remaining sigmoid and descending colon, and an ileosigmoid fistula (Fig. 5). This area of constriction was apparently the site of the autoanastomosis which followed the colocolic intussusception. On December 4, 1948, the barium enema was repeated and there was now a complete obstruction to the flow of barium at the level of the stricture. Surgical exploration of the abdomen was performed on May 7, 1949. The abdominal and retroperitoneal organs were normal except for a 10 cm. fibrous stricture located between the descending colon and the rectal stump. The fibrous band was resected and the bowel ends were joined by a primary end-to-end anastomosis. The vena cava and iliac veins were normal to palpation.

The patient developed signs and symptoms of an acute small intestinal obstruction on August 11, 1949. At surgery he was found to have an obstruction of the ileum due to adhesions. He made an uneventful recovery. A partial stenosis at the site of the rectosigmoid anastomosis was repaired on October 21, 1949. The transverse colostomy was closed Novem-

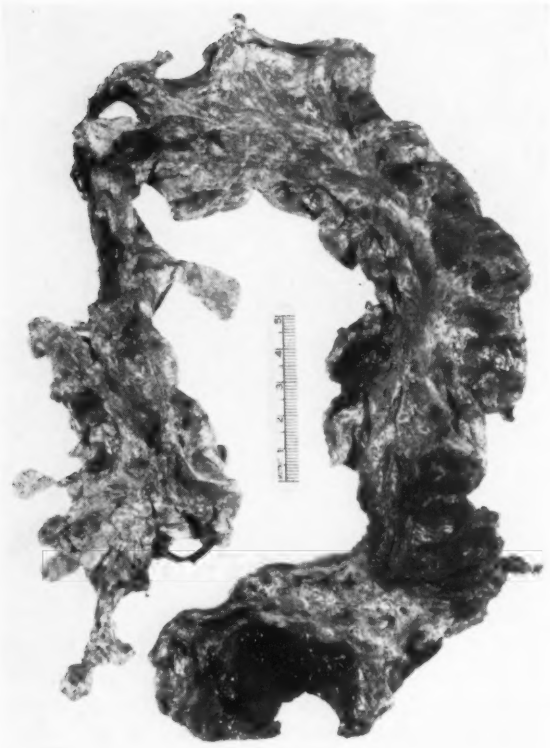

Fig. 4. Sequestrated intussusceptum consisting of 23 inches of gangrenous descending colon with no evidence of tumor or other disease process. Spontaneously expelled per anus twenty-two days after the onset of symptoms.

ber 18, 1949. Since then the patient has remained asymptomatic. Repeated sigmoidoscopic examinations have shown no evidence of any abnormality.

COMMENT

Leichtenstern[7] and Treves[14] (quoted by Bockoven[1]) have pointed out that for spontaneous recovery to occur following sequestration of a gangrenous intussusceptum, sufficient time must elapse for the serosal surfaces of the entering and ensheathing portions of the intestine to become adherent at the neck of the intussusception so that, following separation, perforation will not occur. Also, during this interval, the lumen of the intussusceptum must not become completely obstructed. It was this incomplete obstruction that gave rise to the unusual roentgenologic features which are illustrated in Figure 3. A continuous column of barium is seen extending from the rectosigmoid into the lumen of the intussusceptum, *i.e.*, descending colon, the tip of which has advanced to the relatively fixed portion of the sigmoid which is irregularly constricted. Only a small amount of barium has escaped into the air-filled lumen of the surrounding intussuscipiens. At the time of the examination, this was misinterpreted as a perforation of the sigmoid colon, probably due to carcinoma, surrounded by a large air-containing abscess. No description of intussusception with similar roentgenologic changes has been encountered in our incomplete review of the literature.

Following the auto-anastomosis, a constriction, which progressed to complete obstruction, developed at the site of separation (Fig. 5). This and perforation are the most frequent complications.[7,14,15] Note that, in addition, the patient performed his own ileosigmoidostomy!

Fig. 5. Following expulsion of the intussusceptum a stricture developed at the site of auto-anastomosis. This progressed to complete obstruction. *Inset* Spot roentgenogram of stricture showing ileosigmoidostomy.

There can be little doubt that thrombosis of the inferior vena cava occurred soon after the onset of the intussusseption (Fig. 1). As indicated by follow-up venography and the surgical findings, recanalization subsequently took place. The surrounding inflammatory reaction which accompanied the intussusception must have been sufficient to cause thrombosis of the previously damaged right iliac vein and inferior vena cava. The absence of massive peripheral edema was undoubtedly due to the well established collateral circulation (Fig. 2).

SUMMARY

A case of colocolic intussusception followed by spontaneous extrusion of a gangrenous intussusceptum, 23 inches of descending colon, and recovery is reported. This was complicated by (a) thrombosis of the inferior vena cava which later recanalized, (b) progressive stricture and spontaneous ileosigmoidostomy at the site of auto-anastomosis.

An unusual roentgen manifestation of intussusception is described. When a patent intussusceptum advances into a relatively fixed intussuscipiens, *i.e.*, descending colon into sigmoid colon, examination by barium enema may reveal a continuous column of barium with changes simulating carcinoma, bowel perforation, and abscess formation.

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ROENTGENOLOGICAL FINDINGS IN AMYLOIDOSIS OF STOMACH*

A CASE REPORT

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THE interesting roentgenological findings in this case and the absence of any reference in the English roentgenological literature to amyloid infiltration of the stomach have prompted this discussion.

CASE REPORT

The patient, a Negro male, aged forty-eight, was admitted to Saint Luke's Hospital on September 10, 1949, because of persistent vomiting for a period of three days. He had had intermittent vomiting and abdominal pain for a decade. Recently, the pain had become more severe. It was primarily epigastric, but was referred throughout the entire abdomen. He denied hematemesis. Food augmented the symptoms, and the patient had voluntarily placed himself on a meat-free diet for a period of one year. There had been a 10 to 15 pound weight loss.

FIG. 1. Right anterior oblique view of stomach showing marked mucosal folds.

The past history revealed that syphilis had been diagnosed in 1940 and "adequately treated." The Kline cardiolipid was 2 plus in October, 1948, and without antiluetic therapy was twice negative in September, 1949.

No significant physical findings were recorded.

Urinalysis revealed a specific gravity of 1.010, two plus protein and 12 to 16 white blood cells in the sediment per high power field. The red blood cell count was 3.75 million, hemoglobin 9.5 gm. per 100 cc. and the white blood cell count was 10,500. The differential count showed 36 per cent mature polymorphonuclears, 22 per cent band forms, 33 per cent lymphocytes, and 9 per cent mononuclears. Chemical analysis revealed a non-protein nitrogen of 123 mg. per 100 cc. with a total protein of 6.9 gm. per 100 cc. Other findings were: cholesterol, 183 mg. per 100 cc., sugar, 140 mg. per 100 cc., sodium chloride 535 mg. per 100 cc., and carbon dioxide combining power, 34 volume per cent. The cephalin flocculation was 2 plus in forty-eight hours.

Roentgenographic and roentgenoscopic examinations of the stomach revealed the pronounced mucous membrane folds shown in Figure 1. These were completely effaced by peristalsis as shown in Figure 2. A roentgenographic diagnosis of lymphoma or gastric edema was entertained.

The clinical diagnosis was chronic pyelonephritis. The patient was discharged, to be treated on an ambulatory basis.

There was a steadily retrogressive course. Because of this, the patient was re-admitted one month later, on October 11, 1949. No abnormal physical findings were elicited. The cystoscopist reported a normal urinary bladder. The non-protein nitrogen was 98 mg. per 100 cc. The prothrombin time was 64 per cent. The Mosenthal test revealed a fixed specific gravity. The serum calcium was 11.2 mg. per 100 cc. and the

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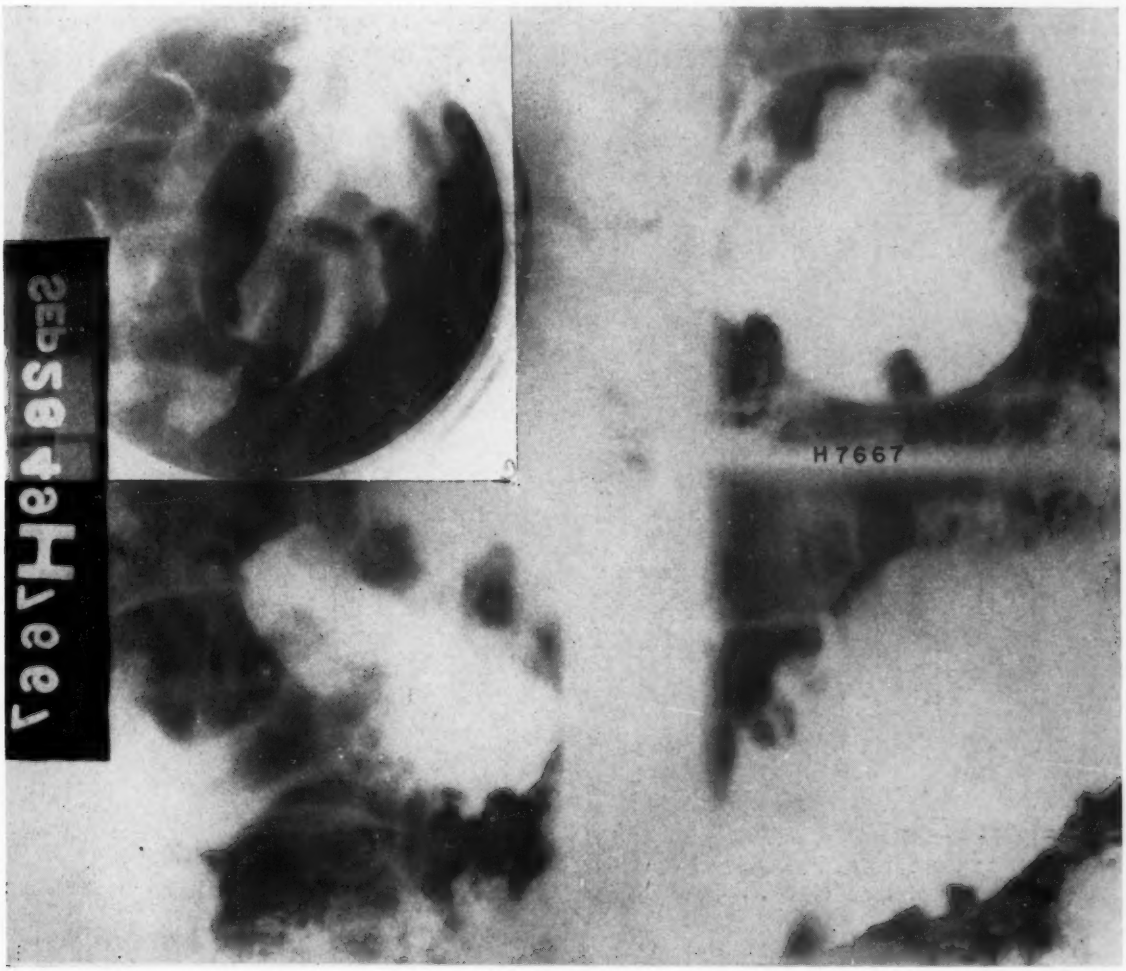

Fig. 2. Roentgenoscopic spot film demonstrating obliteration of folds by peristalsis.

inorganic phosphorus was 7.0 mg. per 100 cc. Additional normal laboratory findings were: gastric analysis, electrocardiogram, and spinal fluid Wassermann.

Another examination of the stomach confirmed the previously reported findings. Gastroscopic examination revealed a normal appearing stomach. The gastroscopist thought that the necessary distention for satisfactory visualization of the stomach had obliterated the prominent folds seen by the radiologist.

Again, the patient was discharged, after moderate improvement on symptomatic therapy. The diagnosis was changed to azotemia of unknown etiology.

During the following two months, the patient was treated symptomatically in the Out-Patient Department. The nausea and vomiting improved. He developed pain about the hands and wrists. These were tender, swollen, and there was weakness of the arms. The uric acid was 7.6 mg. per 100 cc., and colchicine gave some relief.

The final admission was January 29, 1950, because of recurrence of nausea, vomiting and epigastric pain. The only physical findings were lethargy and malnutrition. The total white blood cell count revealed 59,000 cells with a differential of 11 per cent mature polymorphonuclears, 16 per cent band forms, 4 per cent metamyelocytes, 2 per cent myelocytes, 13 per cent lymphocytes, and 54 per cent plasma cells. The non-protein nitrogen was 139 mg. per 100 cc. Bence-Jones protein was absent on several examinations. Roentgenograms of the chest, skull, right shoulder and pelvis were normal. The sternal marrow revealed a majority of plasma cells. The Congo red test was positive.

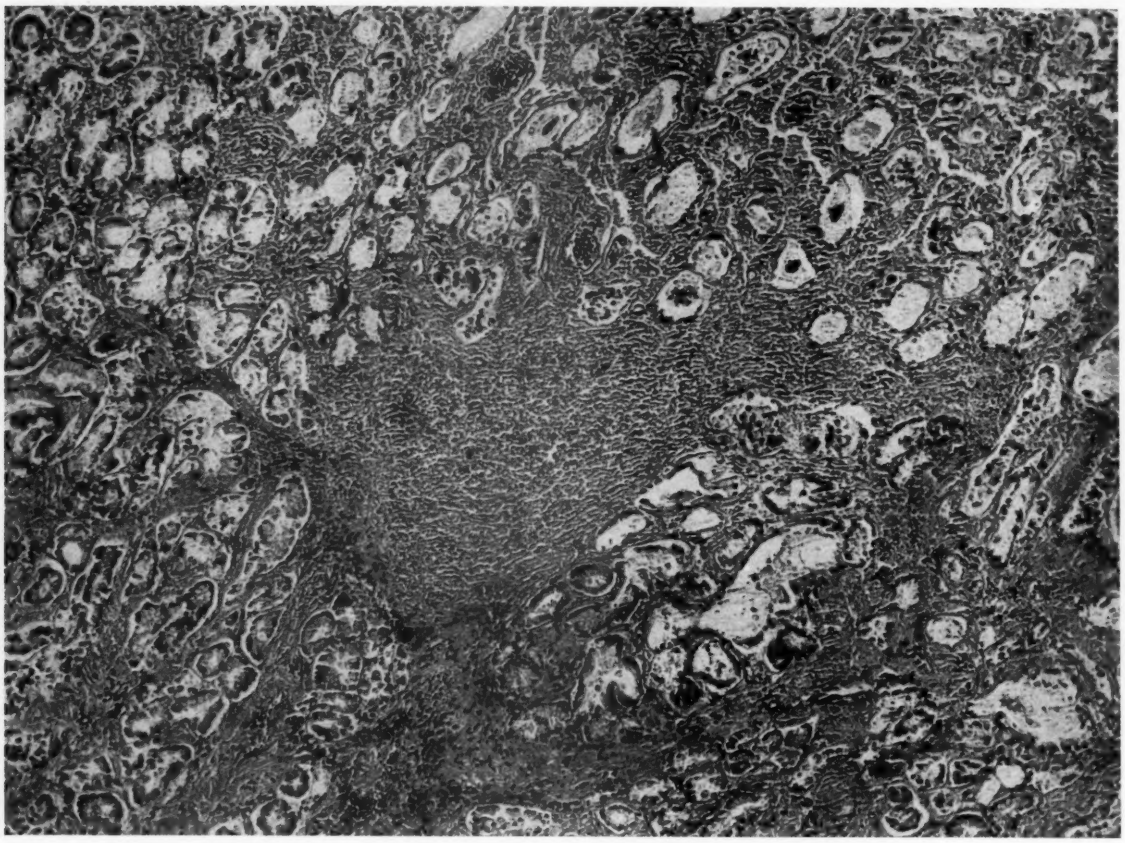

FIG. 3. Photomicrograph (×100) of pyloric mucosa showing central nodule of amyloid. Other strands of amyloid separate glands.

The patient was started on urethane, but died on the seventh hospital day.

*Pathological Findings.** (1) Chronic pyelonephritis, marked; (2) amyloidosis of spleen, duodenum and small intestine, marked; stomach, skeletal muscles, heart, lymph nodes, and colon, moderate; (3) plasmacytosis of bone marrow and liver; (4) luetic meso-aortitis; (5) uremia, cause of death.

DISCUSSION

Amyloidosis has been classified pathologically into four groups.[6] In order of their frequency, they are:

1. *Secondary Amyloidosis:* This is secondary to tuberculosis, suppurative and other chronic diseases. The organs most frequently involved are: spleen, kidneys, liver and suprarenal glands.
2. *Primary Amyloidosis:* No known relationship to other diseases has been established in this form. The usual distribution of the secondary form is not found. There is a predilection for mesodermal tissues, such as skeletal muscles, joints, bones, subcutaneous tissues, smooth muscle of the arteries and gastrointestinal tract, and the heart.
3. *Amyloidosis Associated with Myeloma:* Various authors report the incidence of amyloidosis in myeloma as high as 10 per cent.[6,8] The distribution of the lesions usually follows the primary form.
4. *Amyloid Tumors:* These are localized, lobulated masses most frequently found in the larynx and in other portions of the respiratory and urinary tract.

It is evident from this classification that the primary form of amyloid disease and that form associated with myeloma, having a primary distribution, would be most

* We wish to express our appreciation to Dr. Rafael Dominguez, Director of the Department of Pathology, Saint Luke's Hospital, Cleveland, Ohio, for the pathological studies used in preparation of this report.

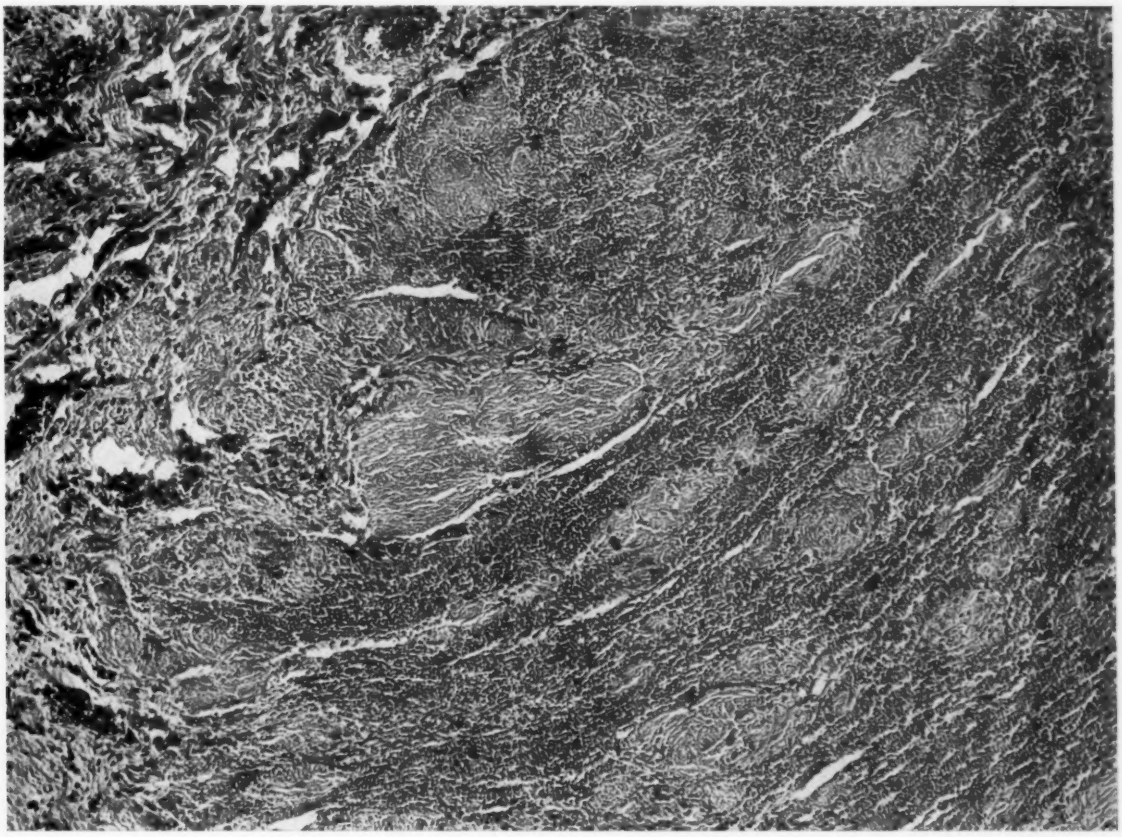

Fig. 4. Photomicrograph (×100) of pyloric muscularis. The light staining areas are amyloid.

likely to present gastric manifestations. Approximately 50 cases with the primary distribution have been reported. Only 1 case, that of Clausen,[1] specifically refers to the roentgenological manifestations in the stomach. His case presented a 2 cm. filling defect in the antral portion of the stomach with absence of peristalsis in this region. The defect simulated a gastric carcinoma.

By reviewing the primary cases that have been reported, 5 others were found to have had upper gastrointestinal roentgen findings. Steinhaus[14] and Golden[4] each had a case of amyloidosis simulating carcinoma of the antrum.T here were 2 cases reported having an ulcer on the lesser curvature of the stomach and another with a duodenal ulcer.[13]

The present case has a totally different manifestation in that there were remarkably prominent gastric folds which were completely effaced by peristalsis (Fig. 1 and 2). The same changes were found at a second examination, two weeks later. When the patient died, four months later, there was amyloid infiltration of the mucosa and muscularis of the stomach (Fig 3 and 4). The routine sections of the stomach revealed a predominance of amyloid in the muscularis We cannot correlate the predominance of amyloid in the muscularis at autopsy and the excellent peristalsis noted roentgenoscopically. Gottron[5] has reported a case with thickened mucosal folds similar to the case being reported but with diminished peristalsis. Including the present report, a total of 8 cases with abnormal roentgen findings have been recorded.

In addition to those already mentioned, there were 5 other cases not examined roentgenographically, that showed gross pathological findings in the stomach due to amyloid infiltration. Three of these[2,3,10] had antral erosions. One had a thickened

antral wall [12] and another had 2 to 3 cm. nodules in the antral wall.[12] Including the present case, a total of 13 of the approximately 50 cases reported have had definite gastric abnormalities.

With the bizarre manifestations presented, it is not surprising that amyloidosis of the stomach has never been diagnosed roentgenologically. The gastrointestinal symptoms—nausea, vomiting epigastric pain and hematemesis—are common in many diseases and are in no way suggestive of the type of lesion. Briefly the signs and symptoms of amyloidosis are those associated with the organs involved. A clue to the diagnosis lies in recognition of the symptom complex having this peculiar organ distribution. Some cases have been confirmed by biopsy. The Congo red test, if strongly positive, is considered pathognomonic.

Although one cannot hope to make an objective roentgen diagnosis of amyloidosis of the stomach, the possibility could be suggested when there are any of the previously described gastric findings: (1) In patients known to have amyloidosis, (2) in patients with myeloma or plasmacytosis, or (3) in patients with bizarre symptoms referable to the organs involved by primary amyloidosis.

The case reported was a diagnostic problem. The detection of plasmacytosis finally suggested the possibility of amyloidosis. It is of interest to note that no roentgen findings of myeloma were detected. This may be due to the short duration of the disease. However, the case may represent the type of myeloma that would cause osteoporosis by diffuse infiltration of bone rather than local bone destruction.

SUMMARY

(1) Of the approximately fifty cases of primary amyloidosis reported in the literature, thirteen were found to have had roentgenological or gross pathological abnormalities of the stomach.

(2) The roentgen manifestations are variable. There may be gastric or duodenal ulceration, findings simulating carcinoma of the pylorus or antrum, or massive mucous membrane folds, with or without loss of peristalsis.

(3) Clues to the diagnosis are the recognition of symptoms referable to the organs involved in primary amyloidosis and the possible association of amyloidosis with myeloma or diffuse plasmacytosis (plasma cell leukemia).

(4) A case of primary amyloidosis of the stomach with roentgenological findings has been reported.

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Vol. 68, No. 2

DIAGNOSTIC KIDNEY PUNCTURE IN CYSTS AND TUMORS*

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EARLIER, several cases of solitary kidney cysts were operated upon as suspected tumors, and deaths occurred. Attempts were made to differentiate these conditions by arteriography on specimens by this method. However, it was found that tumors which were hypovascular could be mistaken for cysts. Later on, this was also demonstrated by aortography on patients (Fig. 1).

In 1944 a method of percutaneous puncture of the expanding focus within the kidney was performed. The puncture was followed by injection of contrast medium into the focus.[1]

TECHNIQUE

During intravenous urography or retrograde pyelography the patient is placed in the prone position with the diseased side slightly elevated. During roentgenoscopy a centimeter scale is placed on the back, opposite the kidney. In the lateral view the depth of the kidney and the focus from the skin is determined by the aid of a scale.

After anesthesia of the skin and muscles of the back opposite the expanding focus, a small puncture needle is introduced. It is directed at the center of the focus and this direction is checked by repeated roentgenoscopy. If the focus is small, the patient is instructed to hold his breath in that phase at which the focus lies opposite the needle point. The needle is then inserted into the focus.

The needle should be equipped with a mandrin in order to avoid plugging of the lumen with tissue. This is then withdrawn when the needle has reached the focus.

In cases of cysts, the fluid flows out immediately. In most cases of tumors, blood drips out instead. A solution of 35 per cent perabrodil (dijodon, diodrast, umbradil) and a little novocain is injected into the focus; in cases of cysts, after partial emptying. Anteroposterior and lateral views are then taken.

MATERIAL AND DIFFERENTIAL DIAGNOSIS

Since the start of this method 80 cases have been punctured; 40 cysts, 34 kidney tumors, 3 pararenal tumors, and 3 normal kidney structures. The indications were: an expanding focus found at urography in cases with hematuria; increased blood sedimentation; fever; tumor metastases with no other signs or symptoms.

Cases with definite signs of tumor, such as projection of the tumor into the pelvis, very irregular deformity of the pelvis, large, solid tumors with decreased kidney function were not punctured. During the puncture era 59 cases were operated upon without puncture: 55 were hypernephromas or cancers, 2 were extremely large capsular tumors and 4 were pelvic tumors. Still another case of an expanding focus in a kidney with presumed metastases in a lumbar vertebra was operated upon without a diagnostic puncture; the kidney focus was found to be a cyst and the destruction in the vertebra was caused by a giant cell tumor. This case strengthens my belief that a diagnostic puncture is indicated in every case in which the diagnosis of a tumor is questionable.

As seen in Table 1 hematuria, increased blood sedimentation and fever occurred more often in the tumor cases. However, symptoms and signs which may be found in cases of tumors as well as cysts are of little help in the diagnosis of individual cases.

[1] Lindblom, K. Percutaneous puncture of renal cysts and tumors. *Acta radiol.*, 1946, *27*, 66–72.

* From the Diagnostic Department of Roentgenology, Karolinska sjukhuset, Stockholm, Sweden (Chief: Professor Åke Åkerlund). Presented at the Fifty-first Annual Meeting, American Roentgen Ray Society, St. Louis, Mo., Sept. 26–29, 1950.

TABLE I

	Hematuria	Increased Blood Sedimentation	Increased Temperature	Local Pain
Solitary cysts (39 cases)	10[1,2]	21	2	9
Cystic kidneys (1 case)	1			1
Renal tumors (34 cases)	20[3]	29	7	8
Pararenal tumors (3 cases)	1[4]	2	1	2

[1] In 4 cases these were associated bladder tumors.
[2] In 1 case microscopic hematuria.
[3] In 2 cases microscopic hematuria.
[4] In this case an associated bladder tumor.

Only a few cysts were spherical in outline and most of them showed lobulation. Thus, in many cases the shape of the expanding focus was not diagnostic of a cyst or a tumor.

With regard to the outline of the focus, only projection of tumor masses into the pelvis proved to be significant. In addition, spot-like calcifications in the expanding focus were found only in tumors, while a calcified shell occurred in two cysts not belonging to this material of punctured cases.

In cases of a palpable hard mass with

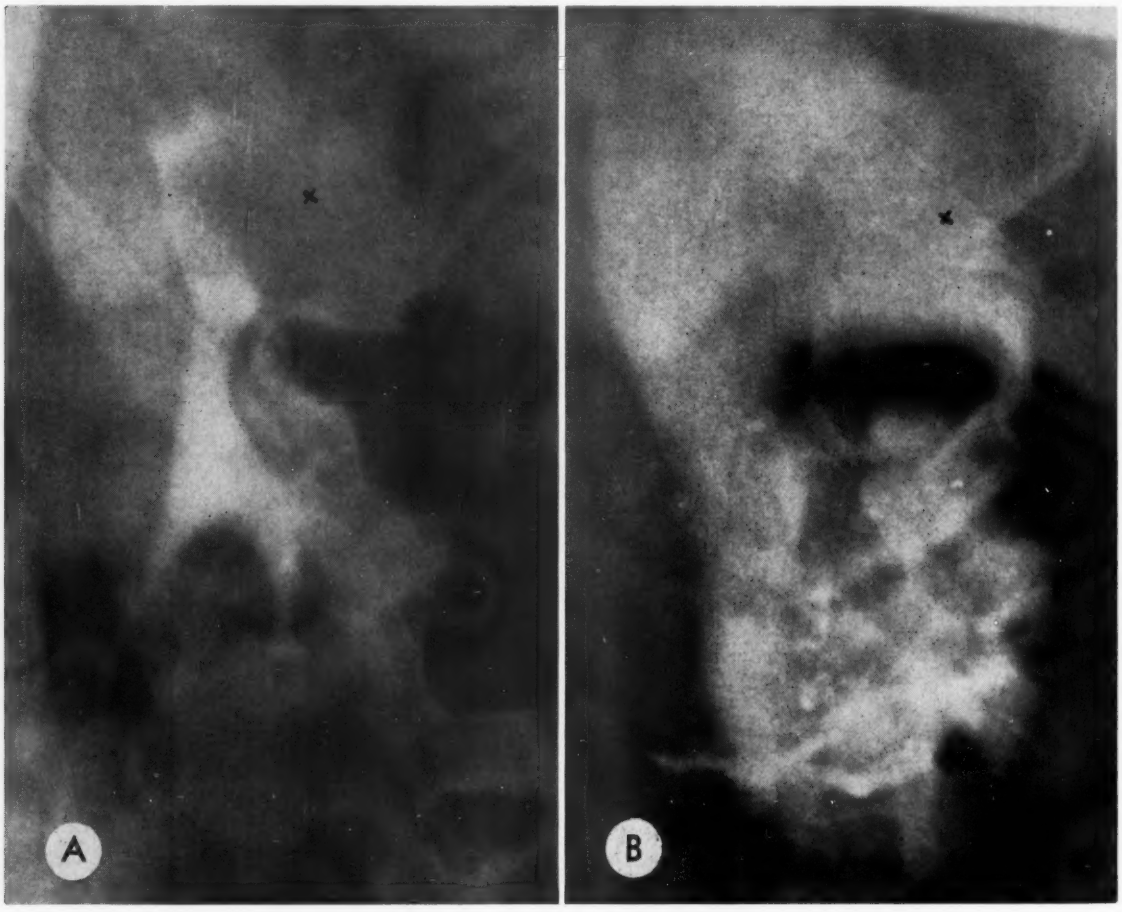

FIG. 1. Excretory urography (*A*) and aortography (*B*) of a case of a rather avascular tumor (*x*) lateral to the upper calyces. No tumor vessels were seen.

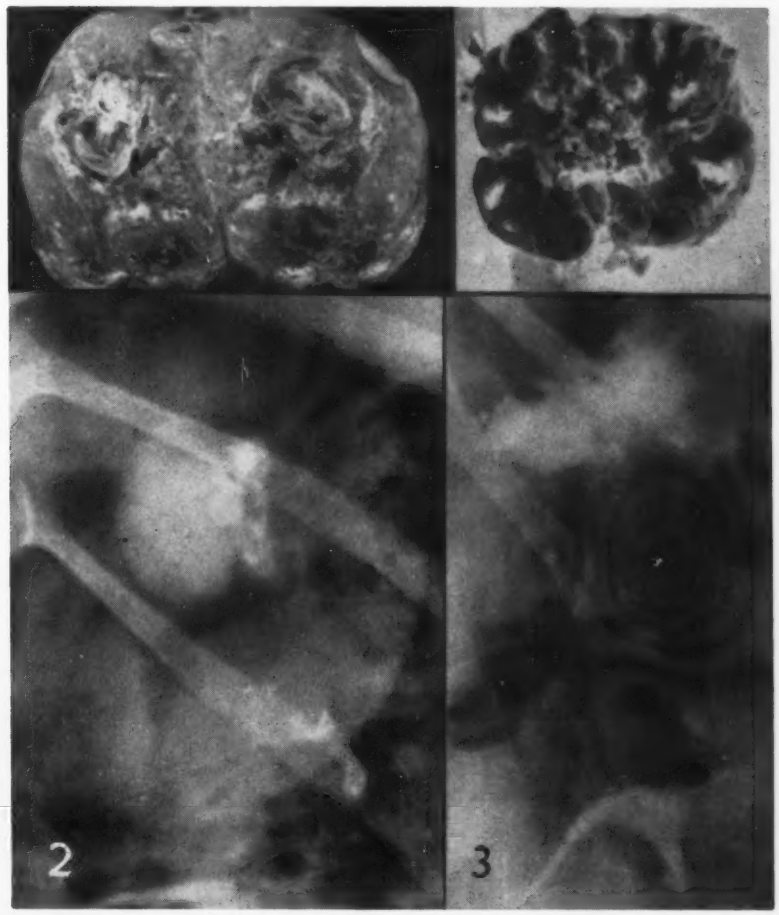

Fig. 2 and 3. Suprarenal tumors punctured and injected with contrast medium. In Figure 2 an adenocarcinoma, in Figure 3 a cortical adenoma with a central cyst. Specimens above.

decreased kindey function or very marked dilatation of the adjacent calyces, the diagnosis of a tumor seemed to be reliable while a moderate dilatation of calyces often occurred in case of cysts.

AORTOGRAPHY OF KIDNEY PUNCTURE FOR DIFFERENTIAL DIAGNOSIS

Objections have been raised to the puncture of a malignant tumor because of the risk of spread of the tumor. The available material of punctured cases is not large enough at this time to evaluate this risk definitely. However, a follow-up examination of the tumor cases showed new metastases only in those cases in which the tumor was invading the veins at the time of operation. The trauma produced by puncture is in all probability less than that produced by manipulations of the tumor during operation.

Aortography would appear to be a better method than kidney puncture to avoid any risk of tumor discrimination. However, as already pointed out, aortography may give misleading information. Aortography was carried out in 3 cases: 2 tumors, and 1 cyst. One tumor showed a typical hypervascularity, while the other, a papillary adenoma without definite signs of malignancy, had vessels which were too small to be demonstrated in the angiogram. The appearance of this tumor could not be differentiated from that of the third case, a cyst.

From the technical point of view kidney

puncture is much easier. As this method gave an accurate differentiation between cysts and tumors it seems to be preferable.

THE PUNCTURE DIAGNOSIS OF CYSTS AND TUMORS

In cases of cysts the fluid began to pour out as soon as the mandrin was withdrawn. From most of the tumors there came pure blood, sometimes pouring, sometimes slowly dripping. These signs would be enough for a differential diagnosis if tumors, with cyst formations, did not exist from which a clear cyst-like fluid may be obtained (Fig. 3 and 8). Also a few drops of blood were obtained from normal kidney tissue in one case. Finally, there were tumors from which no blood was obtained, and occasionally bleeding was seen from a lesion of a cyst wall.

For these reasons an injection of contrast medium is indicated. In cysts the medium sank to the bottom or became mixed with the remaining fluid by repeated withdrawals and injections. On the films the spread of the medium indicated that the whole expanding focus was a cyst (Fig. 4). In the case of a tumor, the contrast medium spread in the tumor in a rather typical manner (Fig. 5–8). On some occasions most of the medium was carried away in tumor vessels. Then injection of about 1 cc. at different levels in the tumors was of help.

After the injection of contrast medium into a cyst, the medium may be withdrawn if aspiration is made with the syringe. This happened in one case of a large cyst from which about 50 cc. was withdrawn after the injection. As the cyst was not visualized on the films, an attempt was made to puncture it again but the cyst was not found. At operation the cyst was collapsed.

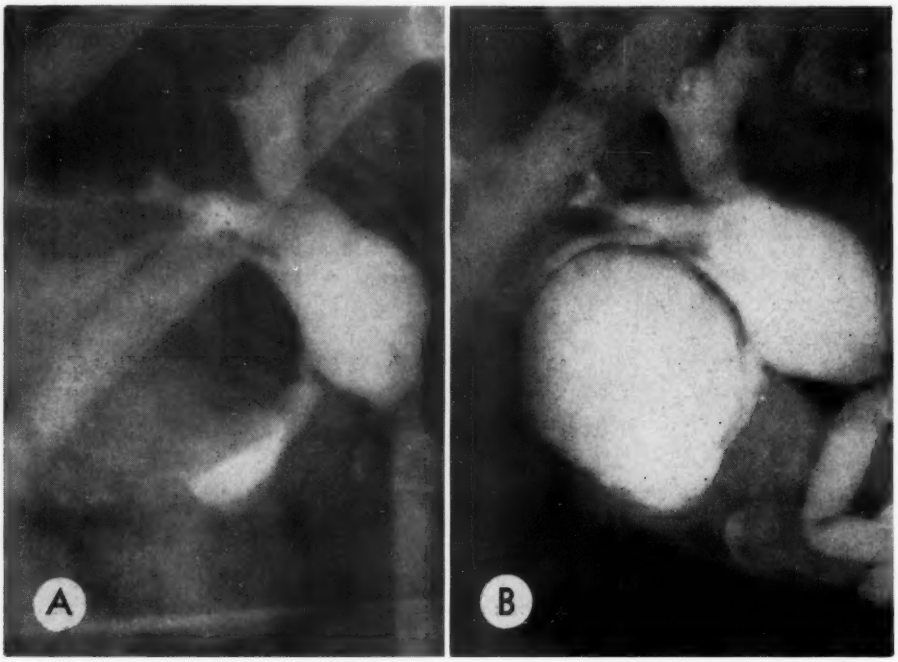

Fig. 4. Solitary cyst before (*A*) and after (*B*) puncture and injection with perabrodil. Note the polycyclic outline of the cyst.

CURATIVE EFFECT ON CYST BY PUNTURE

In some cases the cysts might have caused compression of the adjacent stricture. In a few of these cases, multiple punctures of the cysts were made with a large needle. These cysts were emptied as completely as possible.

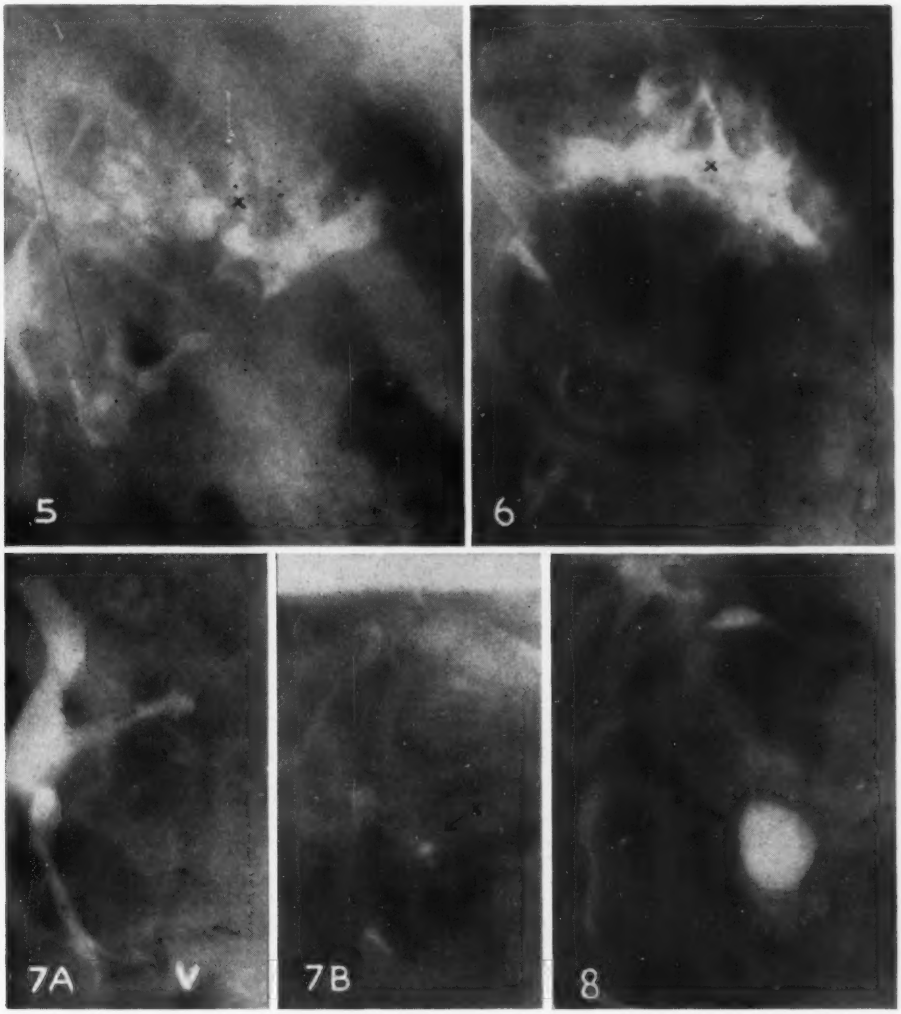

Fig. 5–8. Hypernephromas punctured and injected with contrast medium at *x*. Interlobular spreading in Figures 5 and 6. In Figures 7*B*–8 most of the medium has escaped through vessels. The case in Figure 8 shows a cyst in the tumor.

At follow-up examination two to four years later, the cysts had disappeared in 3 cases (Fig. 9), and had diminished in 2 other cases.

In one case of multiple cysts and hypertension of unknown origin emptying of the cysts by multiple punctures was made. No definite decrease of the blood pressure could be found.

SUMMARY

The difficulty in differentiating kidney cysts from tumors is an indication for percutaneous diagnostic puncture in more than half of the cases.

The cases which do not require a puncture diagnosis are those in which the tumor mass can be seen projecting into the kidney pelvis, and in advanced tumors.

The diagnosis by puncture and injection of contrast medium into the expanding focus is a more reliable method than aortography.

Following puncture, cysts may disappear.

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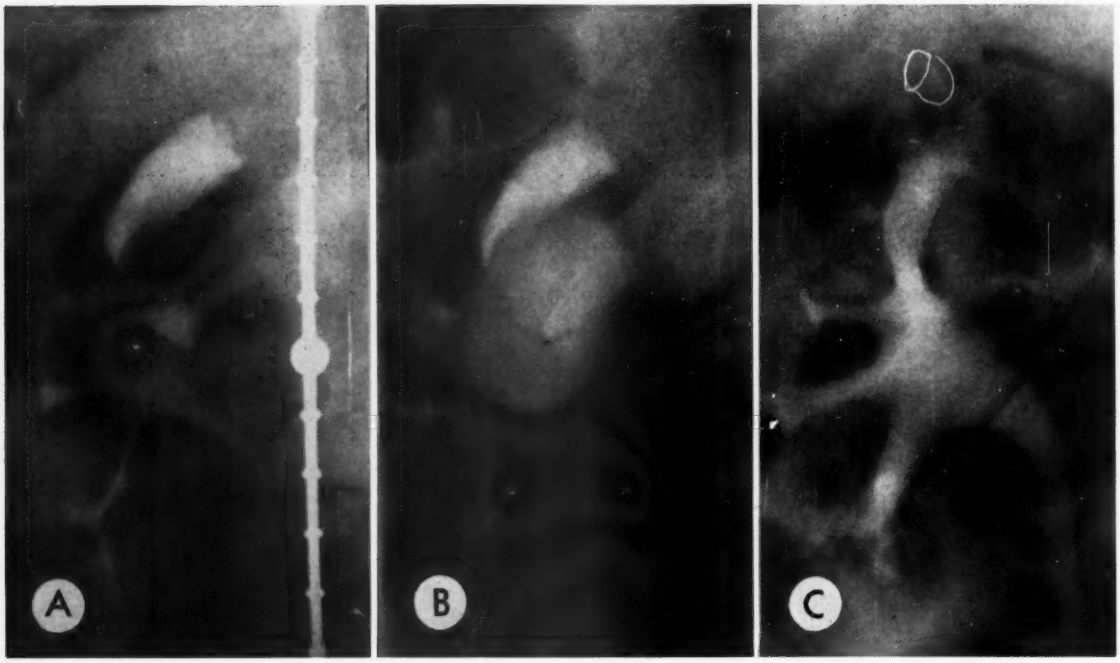

FIG. 9. Case of solitary cyst before puncture (*A*), immediately after puncture and injection with perabrodil (*B*), and the same case two years later (*C*); the cyst has disappeared.

DISCUSSION

DR. CARL A. WATTENBERG, St. Louis, Missouri. I deem it a privilege to have a part in this program, since urologists lean heavily on radiologists in their diagnostic work. Dr. Lindblom has described a very ingenious method of making diagnosis by use of kidney puncture alone, with intravenous pyelograms and roentgenoscopy. I feel sure that by this procedure many an exploratory operation of the kidney can be avoided.

Naturally, the kidney puncture alone is not enough for complete diagnosis. It requires an evaluation of the entire urological study along with the kidney puncture if one is to be sure of the diagnosis.

In 1939, Dr. Archie Dean, of Memorial Hospital, New York City, described a method of treating a solitary cyst of the kidney by aspiration. In his series of 150 kidney aspirations there was no evidence of harm done, and Dr. Dean concluded that the treatment was relatively safe. However, the method described by Dr. Lindblom, using pyelography along with roentgenoscopy, should be even safer and easier.

Naturally, by this method one can make a diagnosis in a patient who is a poor operative risk, and at times, by aspirating the cyst, can make the patient comfortable, and avoid an operation. Sometimes, in studying another illness in a patient, one finds a kidney lesion, and by aspiration can make a diagnosis and save the patient from perhaps two operations, as in the case of the patient in the following slides, which I show simply to illustrate my point.

(Slide) This patient came to Barnes Hospital with a known chest lesion, and upon abdominal examination one could feel a large mass in the right flank; therefore, pyelograms were made. This first slide shows a retrograde pyelogram, with a typical distortion of the right kidney calyces and pelvis.

(Slide) An intravenous pyelogram was made. The slide shows the pelvis; there is a large mass in the lower pole of the right kidney which is suggestive of some tumor.

(Slide) This is a chest film showing the lesion in the left side.

(Slide) This shows the lateral film of the chest and the lesion in the lung.

We operated on the right kidney and found a large solitary cyst; no tumor was found. Two weeks later Dr. Graham of Barnes Hospital explored the left chest and found an epidermoid bronchogenic carcinoma. If we had gone ahead

with the method of aspiration we could have saved this fifty-seven year old man one operation.

The differential diagnosis between renal cyst or tumor can often be a problem. Except for confirmation of hematuria, the only significant finding in the urine in favor of tumor rather than cyst is the presence of tumor cells, as demonstrated by the technique of Papanicolaou. A positive report here is of far more value than a negative report, however. There is still some chance of error with this unless it is done by an expert.

Another method which helps in the differential diagnosis of kidney tumor or cyst is aortography. However, this is not a simple procedure, and it carries a certain risk. Interpretations also are not always correct.

With the procedure of aspiration of the kidney, it is possible to confuse a cystic hypernephroma with a simple cyst. Also, one does not want to overlook the possibility of hemorrhage, infection and pain. This, therefore, makes many of us hesitate to use this method unless there is good indication for it.

Naturally, being a urological surgeon, I feel that if safe diagnostic measures fail to decide the issue, visual inspection and palpation by way of surgical intervention provide the most certain means of differential diagnosis.

Dr. Lindblom is to be congratulated on his fine presentation of a urological roentgenological procedure for diagnosis of kidney tumor or cyst, a procedure worthy of recognition.

ROENTGEN KYMOGRAPHIC LOCALIZATION OF INTRATHORACIC FOREIGN BODIES

By ARTHUR H. JOISTAD, JR., M.D.
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FOREIGN bodies, most commonly of a metallic nature, are frequently encountered during roentgenologic examination. Their location may be carefully sought if the clinical history warrants, but many are found whose presence may or may not be known to the patient, and the finding recorded as "incidental." In most instances, if imperative, these foreign bodies can be localized with a high degree of accuracy. However, if these extraneous objects are confined within the thoracic cage in proximity to heart and great vessels, considerable difficulty in accurate localization can arise, which may be further complicated by concomitant pulmonic and/or cardiac pathology. At times, no definite roentgenologic localization is possible. In such cases cardiokymography is an invaluable procedure.

PRINCIPLES OF APPLICATION

Roentgen kymography, as an additional aid to better localization of "cardiac" foreign bodies, was instituted at a Thoracic Center in the European Theatre when it became obvious that other methods of localization too frequently produced equivocal results. The apparatus itself was devised of spare parts and employed the technique of a moving cassette and a stationary grid having multiple slits. The rationale concerning its use was based on the distinct heart and vessel wave types known to be visible, often even in the presence of juxtacardiac pathology, such as empyema, hemothorax or pyopneumothorax. It was assumed, therefore, that should an opaque foreign body be adjacent to any portion of the cardiac silhouette, and yet be entirely intrapulmonary, it would have continuous movement transmitted to it, containing vascular wave characteristics, and further due to the elasticity of lung tissue, the foreign body would be definitely displaced away from the heart or great vessels. However, if this foreign body should be pericardial-myocardial in location, the displacement would not occur, at least in entirety, but the unbroken wave form would be even more characteristic of its specific vascular location. No characteristic roentgen kymographic picture was anticipated if a foreign body was actually within a heart chamber, inasmuch as its relationship to the structural components of the chamber could not be determined and the picture would be further altered if the foreign body was free or within a thrombus. Although unknown at the time, it has since been learned that Fariñas and Aixala[3] advanced quite similar assumptions, but stressed also the value of tangential incidence of the rays. These authors contended that, if such a foreign body were subpericardial, with tangential rays its contour would be superimposed on the contour of the wall. If it were intracardiac and adherent to the inner surface of the wall, the oblique rays might separate the object from the wall, producing a polycyclic image. Problems of supply and tube capacity limited the present study to posteroanterior projections.

Perusal of the literature discloses only a few scattered references concerning roentgen kymography and intrathoracic foreign bodies. Fariñas and Aixala[3] in 1935 reported an instance of a .22 caliber bullet that under roentgenoscopy displayed "disorganized motion," and which was first believed to be free in the left ventricle. Further study a year later, which included posteroanterior, oblique, and lateral roentgen kymograms, revised their original impression because "its kymogram reproduces faithfully that of the left ventricle contour . . . it is therefore within the wall of the

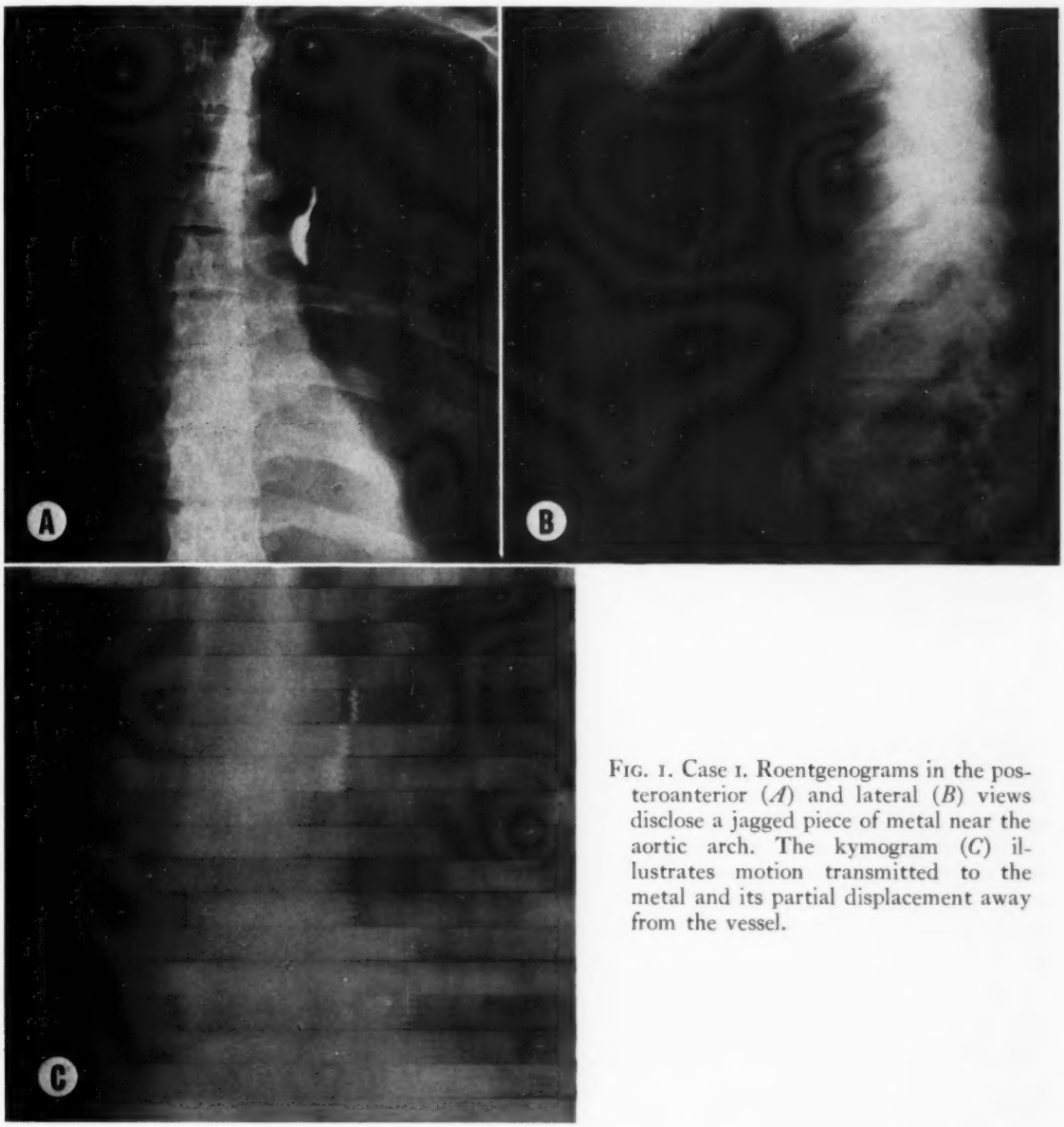


Fig. 1. Case 1. Roentgenograms in the posteroanterior (*A*) and lateral (*B*) views disclose a jagged piece of metal near the aortic arch. The kymogram (*C*) illustrates motion transmitted to the metal and its partial displacement away from the vessel.

ventricle." Cottenot and de Balsac,[1] the following year, presented a description of its use in 3 cases. Two of their patients had tolerated metal in a cardiac location since World War I and the third an attempted suicide with the bullet in the left auricle. Levin,[5] from the Institute of Medicine at Voronezh, U.S.S.R., reported in 1939 a case of accidental injury with penetration of the thorax by "buckshot," five of which were adjacent to the right heart. His roentgen kymographic report reads: "On the right side in the lower segment of the thoracic shadow there is horizontal shading of greater density corresponding to the location of the shot fragments in the right wall of the right ventricle. It is concluded that the foreign bodies lie within the muscle of the right ventricle." In this country, Silverman and Cove[9] record finding, during the course of a gastrointestinal study, a bullet located at the posterior wall of the left ventricle that had been present for forty-one years and was the result of a suicide

failure. Their studies, in spite of normal electrocardiographic findings, indicated that this bullet occupied an infarcted area of myocardium. The following cases have been selected to further illustrate the role of roentgen kymography.

REPORT OF CASES

Case 1. This nineteen year old soldier was wounded in action by an artillery shell fragment which entered the posterior superior portion of his left chest near the axillary line. Roentgenograms revealed comminuted fractures of the infraspinatous fossa and glenoid margin of the scapula, a hemothorax, and a jagged metallic foreign body lying near the inferior aspect of the aortic knob (Fig. 1, *A*, *B*). At roentgenoscopy, the metal displayed pulsations transmitted from the aorta, but it could not be completely rotated away from this vessel nor was it affected by respiration. Roentgen kymographic studies showed the amplitude of pulsations to be of fairly good quality along both cardiac borders, while those in the region of the aortic knob appeared slightly decreased (Fig. 1, *C*). In view of this, it was felt that the central portion of the foreign body was in intimate relation to the knob and had perhaps caused injury to the wall of the vessel. Injury, however, was not confirmed at operation where the metal was found to be "pleural-parenchy-

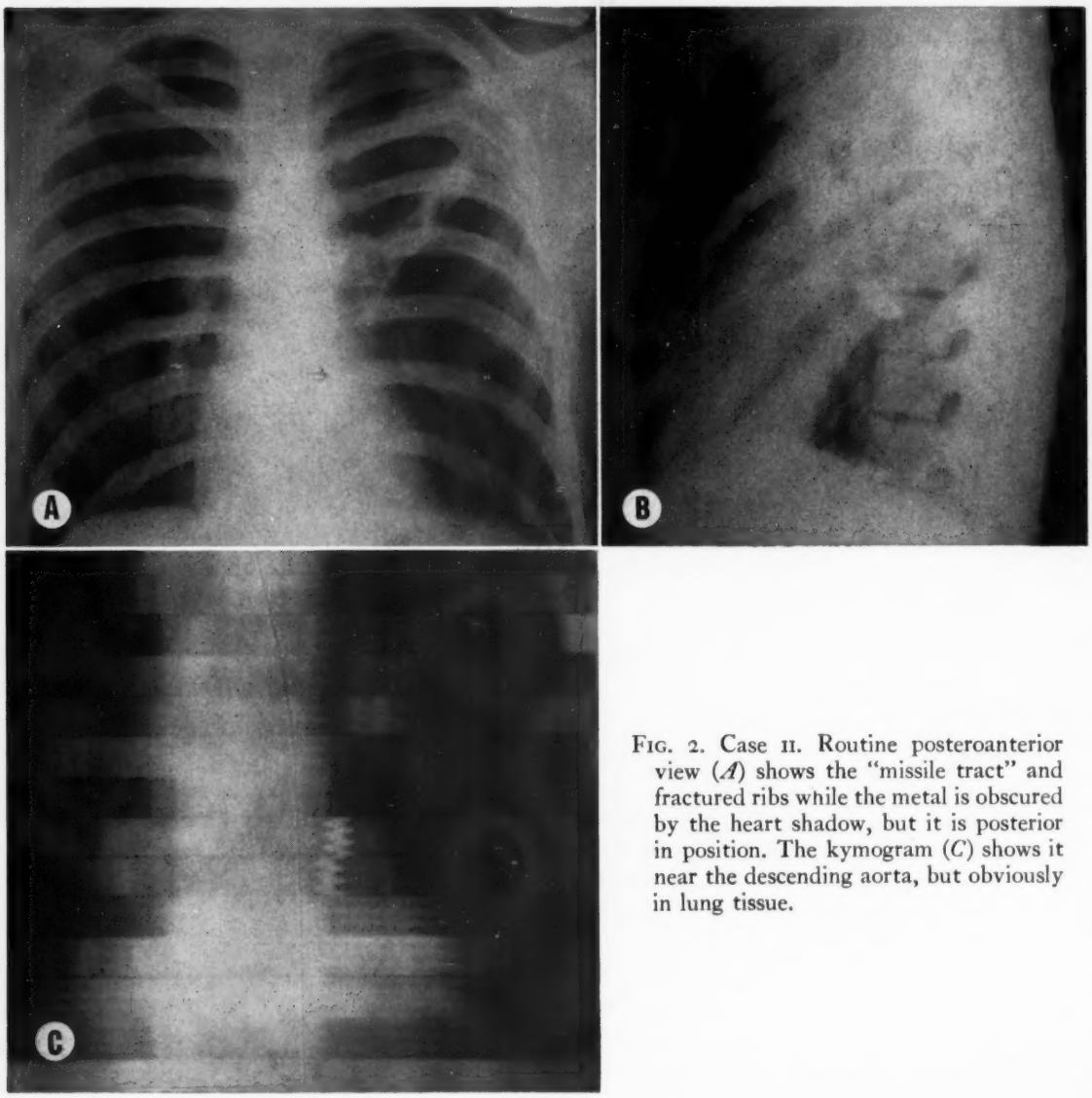


Fig. 2. Case 11. Routine posteroanterior view (*A*) shows the "missile tract" and fractured ribs while the metal is obscured by the heart shadow, but it is posterior in position. The kymogram (*C*) shows it near the descending aorta, but obviously in lung tissue.

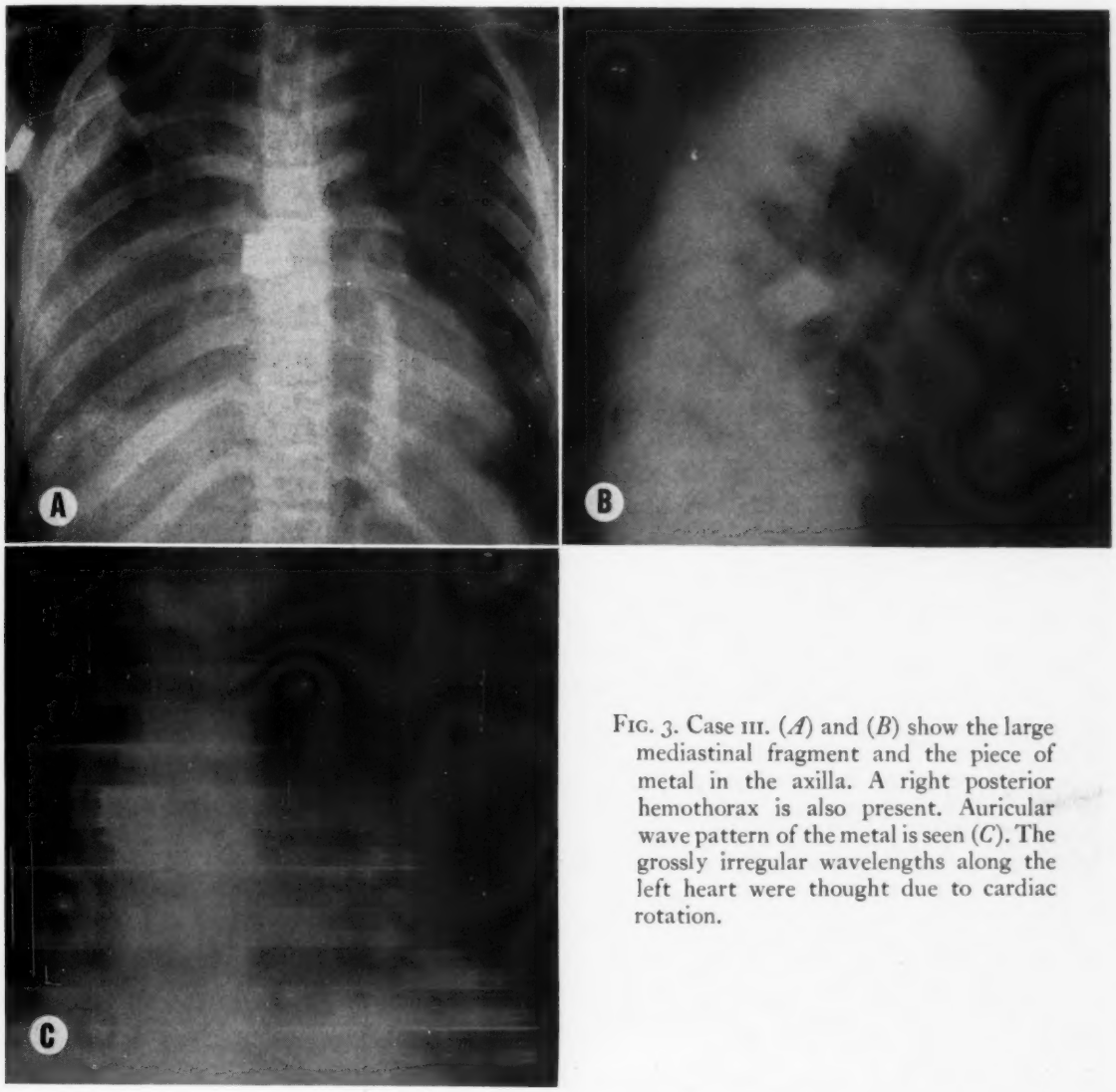


Fig. 3. Case III. (*A*) and (*B*) show the large mediastinal fragment and the piece of metal in the axilla. A right posterior hemothorax is also present. Auricular wave pattern of the metal is seen (*C*). The grossly irregular wavelengths along the left heart were thought due to cardiac rotation.

mal in position and eminently associated with the underside of the arch."

Case II. This soldier was wounded in the left chest by a high explosive fragment. Films following evacuation to the rear showed comminuted fractures of the posterior portions of the left third, fourth, and fifth ribs, foreign bodies in the soft tissue of the left axilla, and a "missile tract" leading to a large rectangular piece of metal lying slightly anterior and to the left of D9 (Fig. 2, *A*, *B*). The diagnosis of an intrapulmonary fragment was made at roentgenoscopy and confirmed by roentgen kymography (Fig. 2, *C*) and at operation.

Case III. This soldier was wounded in the right axilla, resulting in comminuted fractures of the right glenoid fossa, vertebral border of the scapula, axillary border of the right third rib and a right posterolateral effusion. In addition to a large piece of metal in the soft tissues of the right axilla, another was present in the anterior mediastinum. On the roentgenograms there was suggestive motion of both fragments (Fig. 3, *A*, *B*). Roentgenoscopy revealed shallow transmitted pulsations in the region of the mediastinal fragment which anatomically was near the right auricle. Electrocardiographic studies suggested changes consistent with a pericarditis. Roentgen kymography of the left border of the heart showed a very irregular profile which was thought to represent waves of several chamber components following shift and rotation of the heart by the right-sided hemothorax. Although

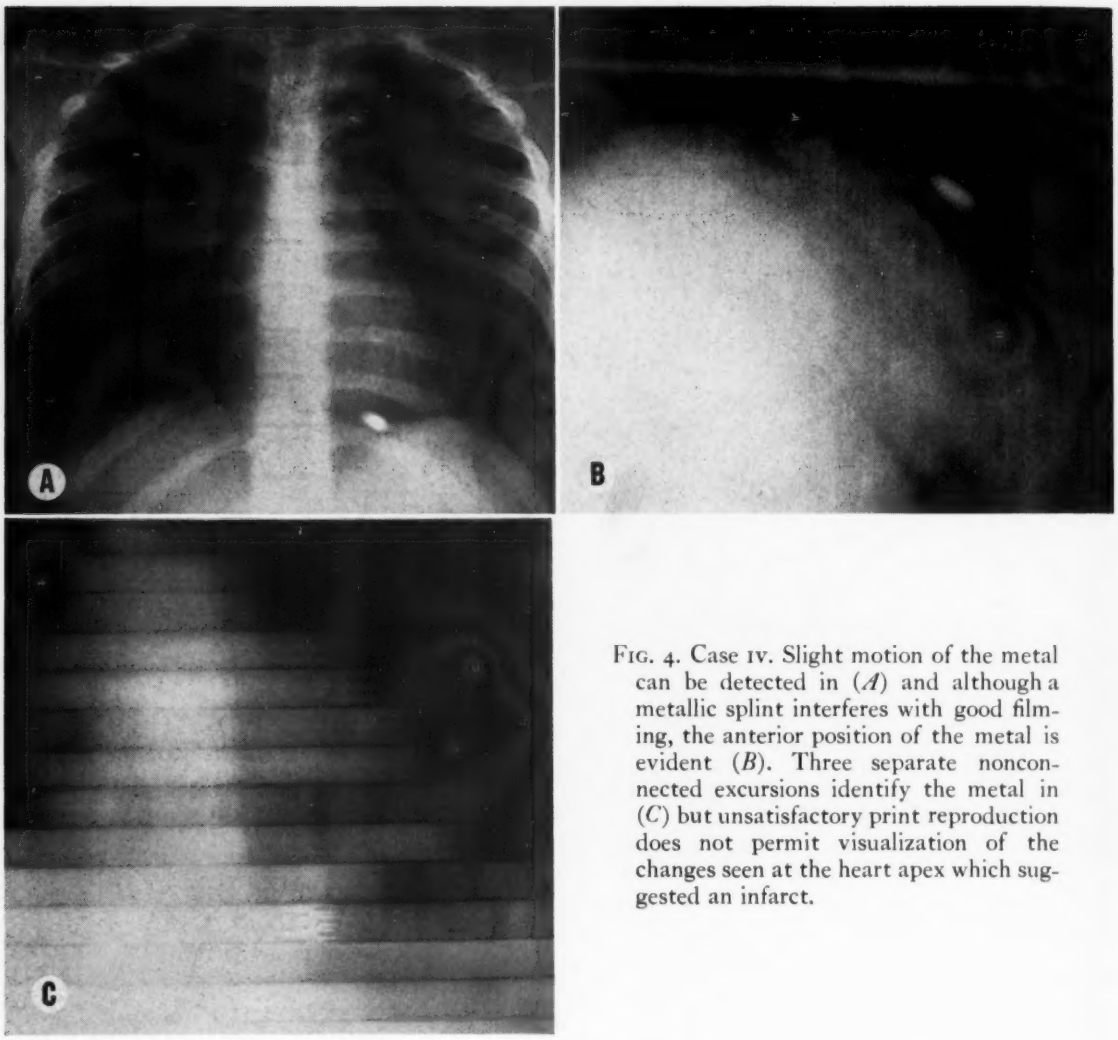


Fig. 4. Case iv. Slight motion of the metal can be detected in (*A*) and although a metallic splint interferes with good filming, the anterior position of the metal is evident (*B*). Three separate nonconnected excursions identify the metal in (*C*) but unsatisfactory print reproduction does not permit visualization of the changes seen at the heart apex which suggested an infarct.

the right cardiac border was generally obscured, there were identified multiple fine serrations at the margins of the metal which suggested transmitted auricular motion. Displacement was minimal, as might be expected, considering the location and dimensions of this fragment (Fig. 3, *C*). At operation, the metal was found "embedded in pericardium, pleura, and lung. A few cubic centimeters of pus were noted about the foreign body, also shreds of clothing. Foreign body was removed without free opening of the pericardium. It was thought that there was some old blood in the pericardium at this time. This was not disturbed." Recovery was uneventful after removal followed by decortication of the basal clotted hemothorax. Postoperative roentgen kymograms and electrocardiographic studies were normal.

Comment. Where the metal was almost totally intrapulmonary, the thrust from the adjacent great vessel or chamber was found to be sufficient to displace it appreciably and impart a distinct unbroken wave form. Strategically located dense pulmonary calcifications were noted to respond in a similar manner. Metal posterior to the heart or vessels ordinarily would be best studied by additional projections.

Case iv. Male, aged twenty-five, wounded by a fragment of shell which fractured the left humerus for which reason the patient was originally admitted. Physical examination revealed a single small and almost healed wound of the left anterolateral chest wall and no other findings. Although there were no symptoms, the patient's chest was roentgenographed as a matter of routine and an unsuspected metallic

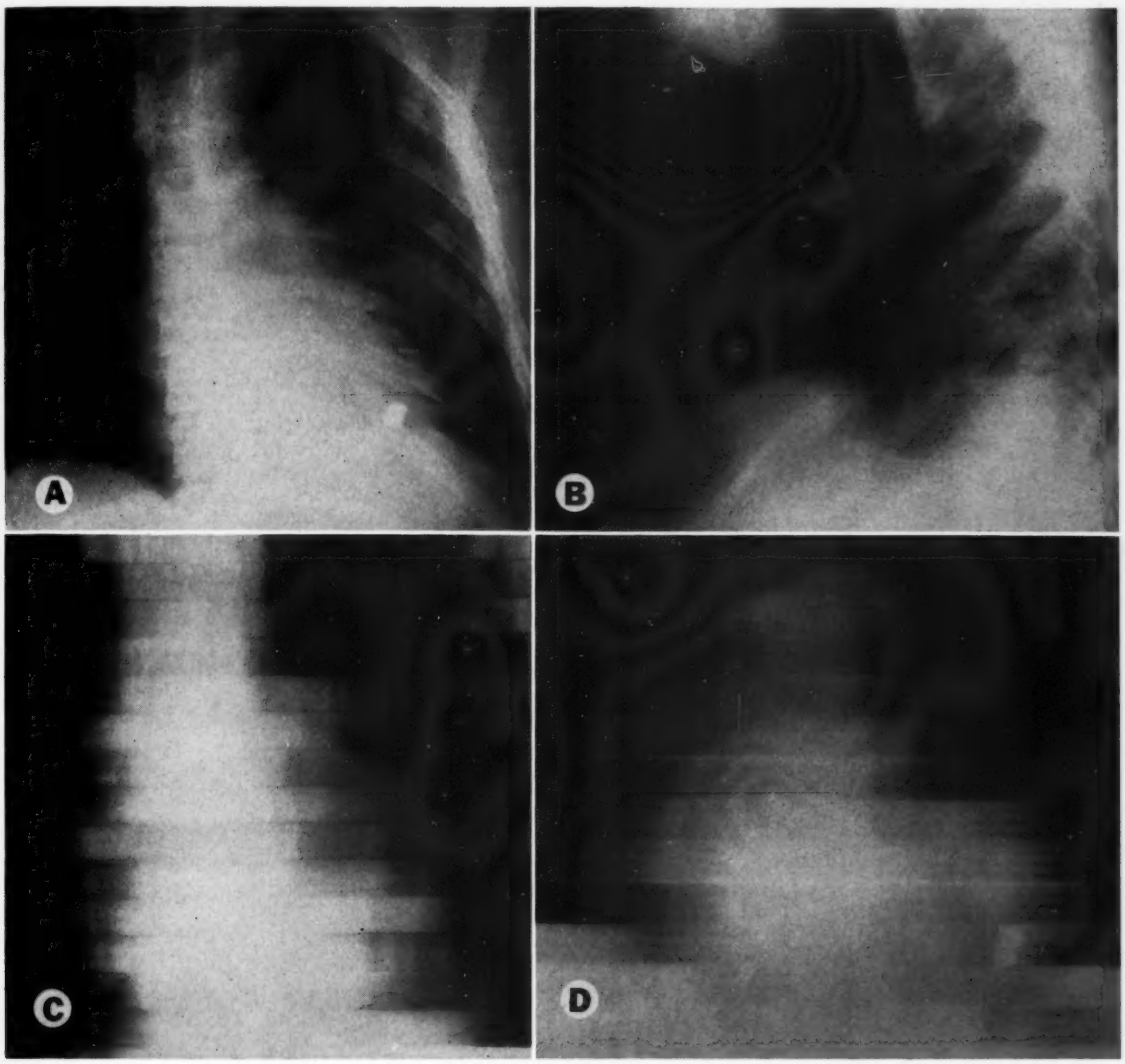


Fig. 5. Case v. Roentgenograms (*A*) and (*B*) show a similar location of the foreign body to that seen in Figure 4. The "silent" cardiac apex in (*C*) later shows fair recovery (*D*), and irregular motion of the metal can be identified.

foreign body, showing motion, identified (Fig. 4, *A*, *B*). With screening, the object appeared ventricular and was located far anteriorly. The impression was that it moved paradoxically to the heart apex and a myocardial position was suspected. Roentgen kymography showed wide nonconnected excursions of the metal which possessed a sharp point at its right margin identified during ventricular diastole. In addition, the apparent amplitude of ventricular systole appeared less than normal and the duration of diastole increased and perhaps splintered (Fig. 4, *C*). It was believed that the metal was intramural in the right ventricle, associated with myocardial damage. Electrocardiographic studies were normal. At operation, "no pericardial scar was found, but the fragment was removed from within the left extremity of the chamber of the right ventricle." Postoperative electrocardiographic studies remained normal and another roentgen kymographic study, made twenty-two days postoperatively, showed none of the original findings.

Case v. Male, aged twenty, wounded by an artillery shell, a piece of which entered the left scapula and comminuted the fourth rib posteriorly. Two days later, the patient developed a cough with hemoptysis and was found to have an extensive pneumohemothorax and was trans-

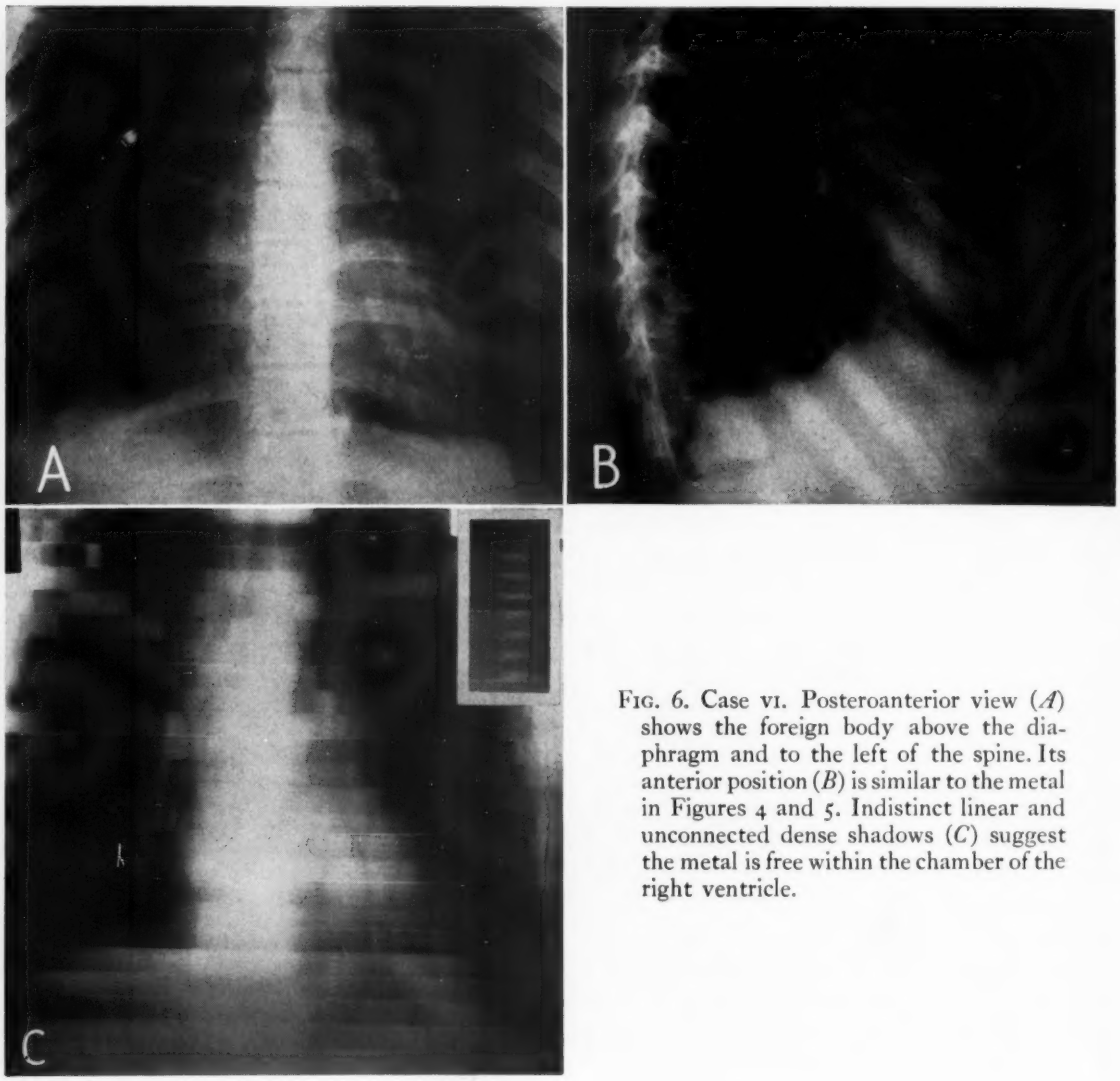


Fig. 6. Case vi. Posteroanterior view (*A*) shows the foreign body above the diaphragm and to the left of the spine. Its anterior position (*B*) is similar to the metal in Figures 4 and 5. Indistinct linear and unconnected dense shadows (*C*) suggest the metal is free within the chamber of the right ventricle.

ferred to a chest center. Here a cardiac foreign body was found, located far anteriorly and in relation to the left ventricle (Fig. 5, *A*, *B*). At roentgenoscopy, the metal moved synchronously with the cardiac apex and was not separable from it. Although cardiac pulsations originally appeared fairly normal, subsequent electrocardiographic findings suggested severe anterior wall damage and perhaps involvement of the left anterior descending coronary artery. The first roentgen kymographic study, sixteen days after original injury and one week following roentgenoscopy, showed classical findings of a severe infarct. No motion of the metal was present and only three disconnected linear lines were evident. It was impossible to definitely associate these with any particular phase of the heart (Fig. 5, *C*). Fourteen days later, on another roentgen kymogram, good recovery of cardiac tone was evident, but there were still low amplitude pulsations at the apex with minimal passive dilatation during systole, suggestive of an aneurysm. The metal showed only irregular motion (Fig. 5, *D*). At operation, fifty-five days after injury, the foreign body was found "in the left ventricle, in a small myocardial aneurysm 1.5 cm. in diameter. The foreign body was ballottable in this defect in the cardiac wall. This position was less than 1 cm. to the left of the anterior descending coronary vessel and one-third of the distance from the apex to the base. Removal of the missile was accomplished without hemorrhage through the presence of a mural thrombus, which was not

disturbed." Recovery was uneventful except for an episode of precordial pain one week postoperatively. Electrocardiography showed persistent damage. Postoperative roentgen kymogram was not obtained.

Case vi. Male, aged nineteen, wounded by a piece of metal with entrance at the right posterior axillary line at the level of the sixth rib. Roentgenograms showed metal having motion situated near the anterior portion of the right ventricle with a smaller fragment located in the soft tissues of the back (Fig. 6, *A*, *B*). Roentgenoscopy placed the intrathoracic metal at the anterior inferior aspect of the right ventricle. With systolic contraction, a vertical "jumping motion" was present, without appreciable lateral movement. Electrocardiographic studies suggested moderate left ventricular damage. Roentgen kymographic studies showed negligible lateral displacement with the unconnected horizontal outline of the metal seen during systole (Fig. 6, *C*). In spite of electrocardiographic studies, this patient was asymptomatic and no operation was done; so its suspected intraventricular location was not verified.

Comment. In a case reported by Samson,[8] a metallic foreign body was removed from an almost identical position to that in Case iv with similar operative findings. Apparently, in both instances embolic phenomena must be considered. Although it is well known that some infarcts have been demonstrated solidly by cardiokymography, it would appear that there was no initial cause for an infarct in Case iv and that the roentgen interpretation was erroneous. However, the complication of a myocardial aneurysm is always to be feared. Loisson[6] has reported 9 cases of late rupture in 254 cases of cardiac injury.

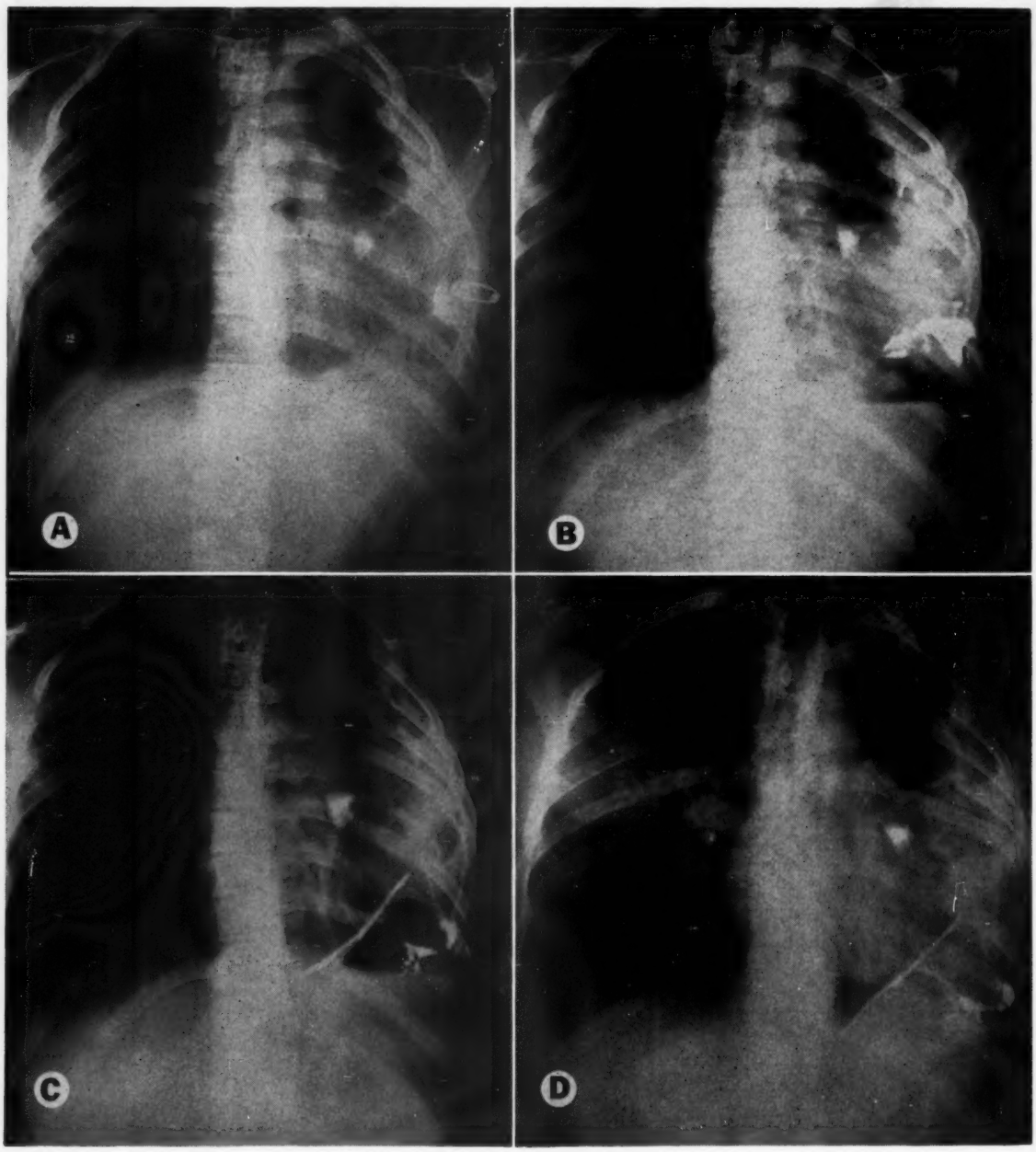
Case vii. Private, aged twenty-five, wounded by a shell fragment which entered the left chest at the level of the third anterior rib which resulted in a sucking wound, and later an empyema which was decorticated. The presence of a foreign body in the left chest was known, but its cardiac relationship could not be determined originally because of the dense empyema. However, repeated electrocardiographic studies revealed anterior wall muscle damage. The hospital course over five months was stormy and was punctuated, on four occasions, by severe hemorrhage from the empyema wound. Film studies during the hospital stay were very revealing: Figure 7, *A*, done postoperatively and seventy-two days after the original injury showed the metal in the left chest with its smooth base parallel to the spine. Motion was present. Re-examination (Fig. 7, *B*) fourteen days later showed the outline of the metal to have changed. Fifty-six days later (Fig. 7, *C*) the position is again changed and in another five weeks (Fig. 7, *D*), a new position is evident. Oblique and lateral film study showed the metal always superimposed on the left posterior superior position of the heart shadow (Fig. 7, *E*, *F*). Roentgenoscopy at this time, almost 177 days after injury, showed the metal to appear partially fixed in its most left lateral portion, while its medial and inferior borders had a "flopping" motion in time with cardiac pulsations which appeared auricular. A roentgen kymogram made at the time of the last examination showed no identifiable wave pattern given to the metal and it was seen only as horizontal dense unconnected lines. This metal was believed to be within the left auricle (Fig. 7, *G*).

At operation, "the empyema drainage site was enlarged anteriorly and posteriorly by further rib resection and the densely adherent empyema pocket and subjacent lung were freed with the greatest difficulty and with considerable damage to underlying parenchyma of lung. These dense adhesions rendered location of the foreign body most difficult. The foreign body was thought to lie in a mass within the left auricle and an instrument could be passed through an old laceration of the pericardium. This pericardium was adherent to the auricle and the exploring finger could be passed into the mass of clot in the intra-auricular position. The foreign body could be made out with a palpating finger and at this point in the operation, the free chamber of the auricle was freely opened, the foreign body was then grasped with a Kochen clamp and delivered without incident." Recovery was uneventful.

Comment. In retrospect, the severe and almost uncontrollable hemorrhagic episodes appeared to have originated from the rent in the auricle. It is not inconceivable that the metal itself may have helped plug

the opening and such an instance has been recorded by Makins.[7] The changing position of the metal, as observed on serial roentgenograms, could be either the result of its disengagement from the thrombus or a new position of the thrombus with its enclosed fragment.

Case viii. Male, aged twenty-eight, wounded in the right chest with laceration of an intercostal artery. Ultimately, an empyema developed which required drainage and decortication. Because of a custom being established, roentgenograms of routine density and with Bucky technique were obtained and an unsuspected cardiac foreign body uncovered. This had unusual linear proportions and was directed vertically over the mid-portion of the heart (Fig. 8, *A*, *B*, *C*). Motion was present in the lateral views (Fig. 8, *D*). Under roentgenoscopy, a pendulum-like motion of its inferior portion was demonstrated, moving right to left with the cardiac cycle. The superior portion of the



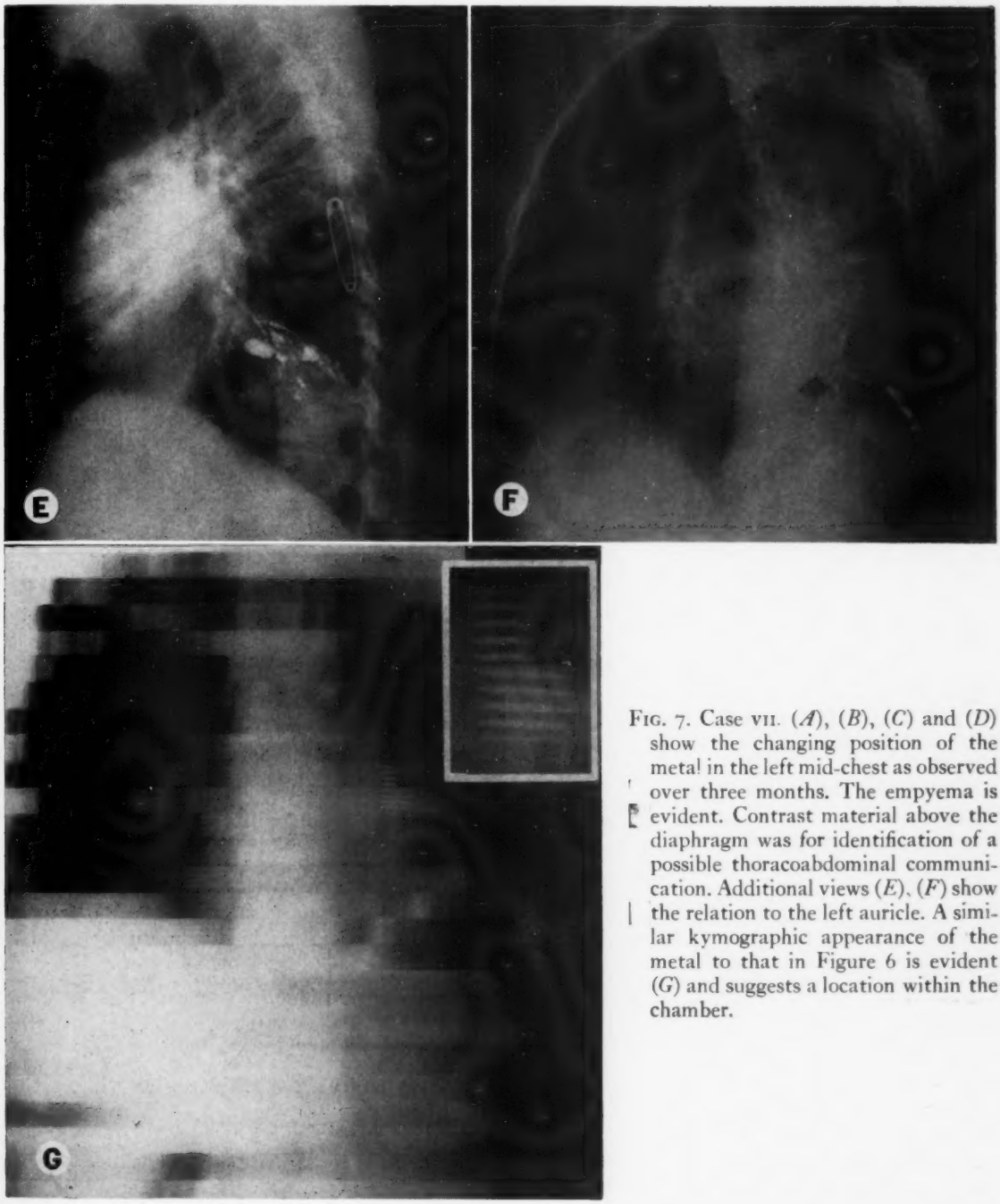


Fig. 7. Case vii. (*A*), (*B*), (*C*) and (*D*) show the changing position of the metal in the left mid-chest as observed over three months. The empyema is evident. Contrast material above the diaphragm was for identification of a possible thoracoabdominal communication. Additional views (*E*), (*F*) show the relation to the left auricle. A similar kymographic appearance of the metal to that in Figure 6 is evident (*G*) and suggests a location within the chamber.

metal appeared fixed. The swinging motion of the metal was apparent on the roentgen kymogram and the excursions to the right and left at the base of the metal were almost equal. However, the uppermost portion showed no distinct motion (Fig. 8, *E*). Repeated electrocardiographic studies were normal except for paroxysmal auricular tachycardia. Clinically, there were no symptoms and no attempt was made to remove this obvious intracardiac fragment.

Case ix. This soldier was struck during an engagement of small arms fire by a bullet that was believed to have ricochetted and entered the right chest posteriorly. His clinical course

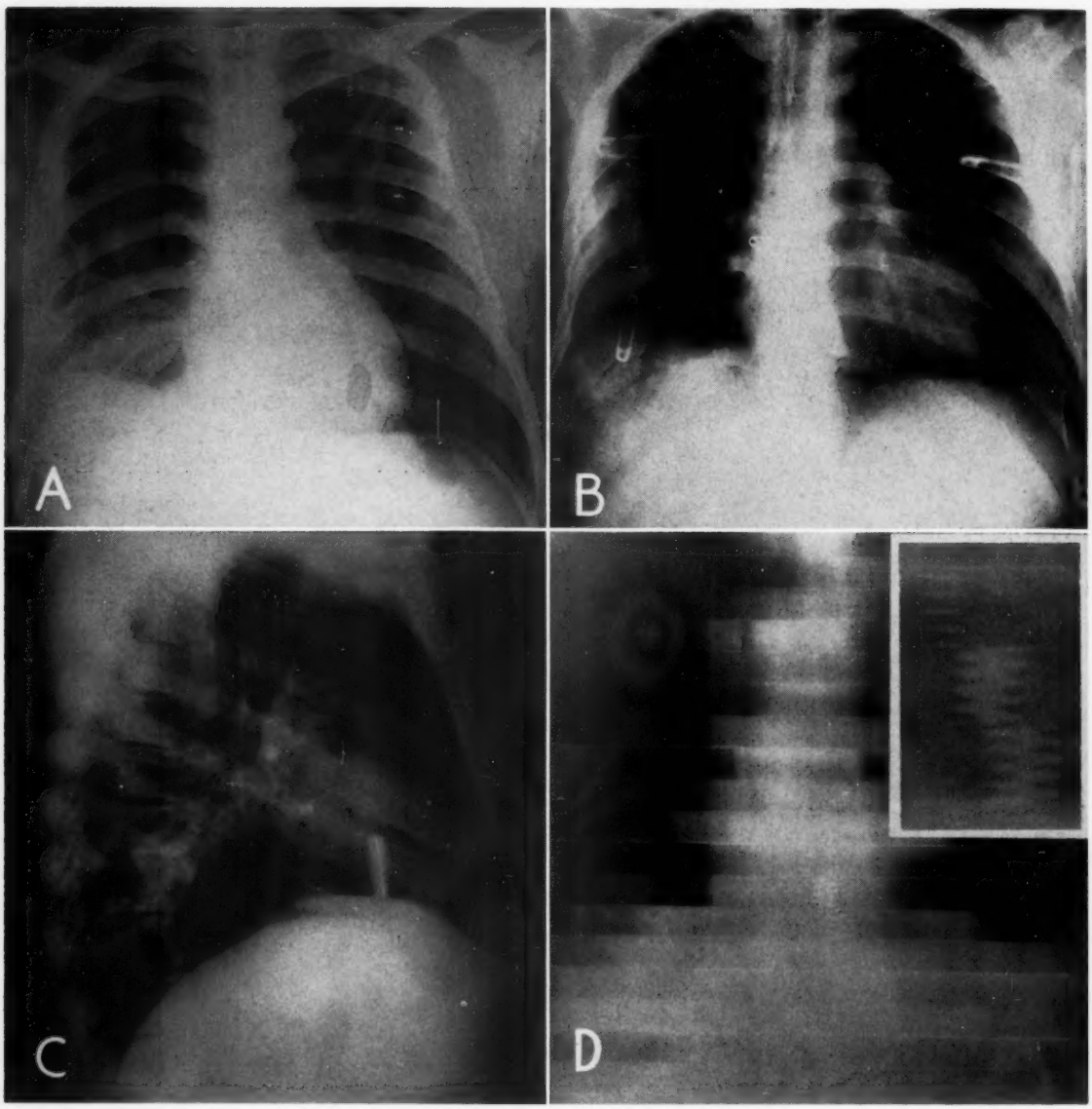


Fig. 8. Case viii. Film of routine density (*A*) demonstrates an empyema but not the large and unsuspected foreign body seen using overexposure technique (*B*), (*C*). In the kymogram (*D*) the lower half of the metal shows ventricular motion while the upper half is unaffected and could be free within the ventricle.

was entirely uneventful and the electrocardiogram not remarkable. Roentgenograms showed two metallic fragments—one quite small, lying slightly posterior to the cardiac shadow and the other almost midline between the ventricles (Fig. 9, *A*, *B*, *C*, *D*). At roentgenscopy, the smaller fragment was fixed, while the larger moved with a right to left and up and down "dancing" motion, but with very little backward or forward displacement. With roentgen kymography (Fig. 9, *E*) the metal was visualized largely during the diastolic phase of ventricular motion but possessed a somewhat more irregular movement than had been seen in other intracardiac foreign bodies of similar size and shape.

The heart was carefully explored at operation and "the entrance hole in the posterior portion of the right ventricle was felt and seen, the wound not having closed itself. It was not possible to even feel the metallic foreign body which was not removed and its relation to the interventricular septum was thought very probable."

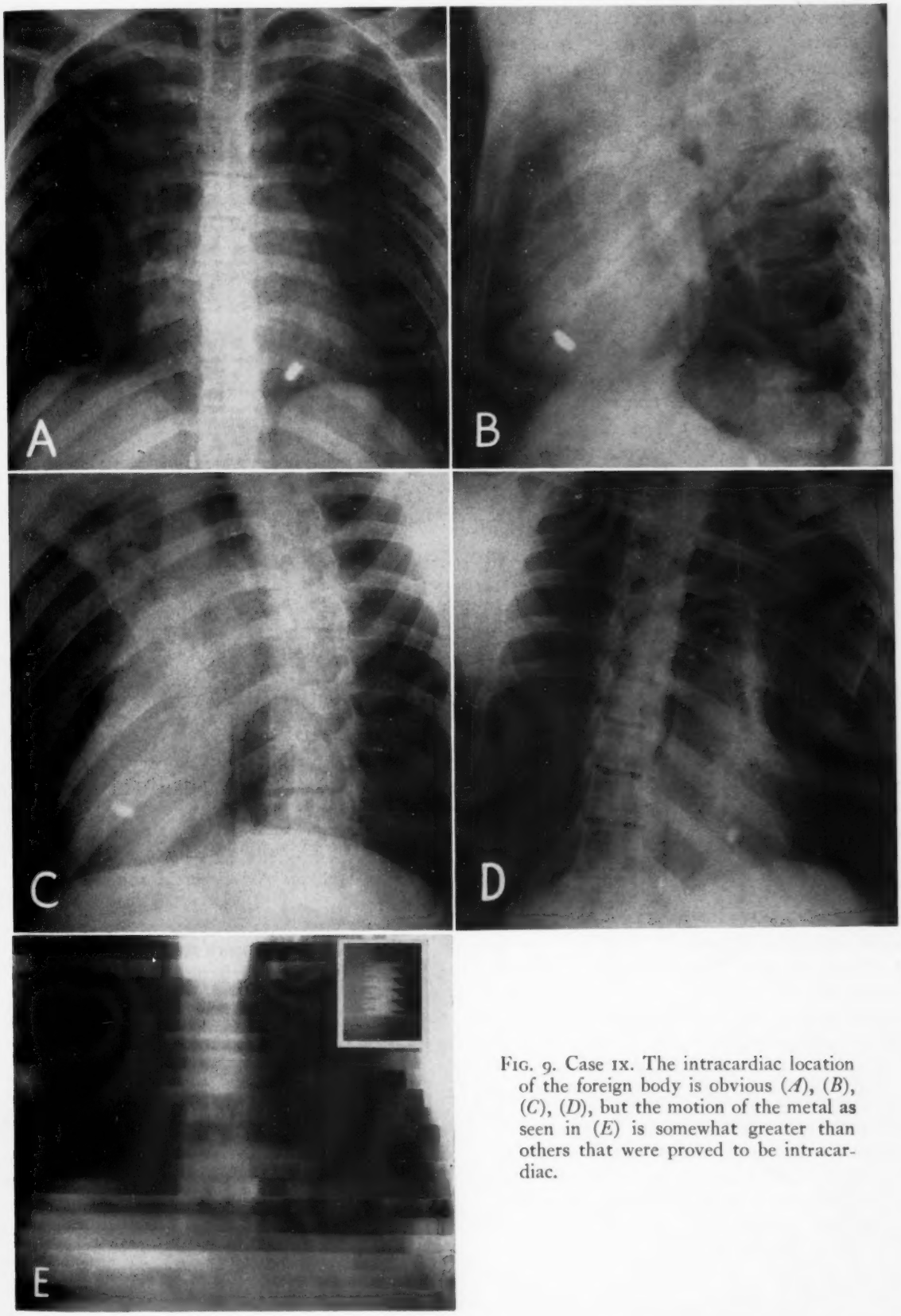


Fig. 9. Case IX. The intracardiac location of the foreign body is obvious (*A*), (*B*), (*C*), (*D*), but the motion of the metal as seen in (*E*) is somewhat greater than others that were proved to be intracardiac.

Comment. According to Hodson,[4] foreign bodies are apt to be in the heart wall if screening reveals a three-dimensional movement, and in or near the interventricular septum if movement is in one plane. This patient made an uneventful postoperative recovery, and had no complaints. No postoperative studies were made.

DISCUSSION

Foreign bodies may be located anywhere within the thoracic cavity and are usually the result of direct violence although they may be embolic or migratory. The statistics compiled by Decker[2] in his study of 100 such cases indicate that the ventricles, notably the right, are chiefly involved, while the auricles and great vessels account for comparatively few of the total. These intrathoracic foreign bodies, especially those having a possible cardiac relationship, are not frequently encountered in peacetime roentgenology, but the total number of known cases might conceivably be greater if exhaustive studies had been done whenever such a possibility existed. Intracardiac foreign bodies cannot safely be excluded by a lack of symptoms or negative clinical findings, since actual penetration of the heart musculature can occur without serious hemorrhage or alarming tamponade. Too, the presence of a hemothorax or empyema may completely obscure a potentially more serious underlying pathology. It is essential, therefore, that routine roentgenograms in more than one plane be supplemented by others with overpenetration and, when possible, by roentgenoscopy If a foreign body is found, meticulous study is required to meet the demands of cardiac surgery. It is felt that the quality of such study can be enhanced by utilization of the too often neglected roentgen kymography.

SUMMARY AND CONCLUSIONS

1. The rationale of roentgen kymography as an aid in the localization of opaque intrathoracic bodies is presented.

2. The literature relating to this usage of the roentgen kymogram has been reviewed.

3. Nine selected cases are presented where roentgen kymography has been utilized as an additional diagnostic aid.

4. The fact that intrathoracic foreign bodies are not necessarily fatal and need not produce symptoms is stressed. If there is any possibility of an intracardiac foreign body, a diligent roentgen examination is indicated.

The author wishes to thank Charles Bernstein, Captain, A.U.S., and Corporal Arthur Feidler, A.U.S., for their assistance in the construction of the roentgen kymograph used in this study. He thanks also the late Dr. A. E. Barclay and his associates, at the Nuffield Institute for Medical Research, Oxford, England, who made possible a cineroentgenographic study of many of these cases.

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A NEW BRONCHOGRAPHIC TECHNIQUE EMPLOYING AEROSOL ANESTHESIA*

FURTHER EXPERIENCES IN CHILDREN AND ADULTS

By JOSEPH B. MILLER, M.D.†, NORMAN DINHOFFER, M.D., *and* WILLIAM H. CONYERS, JR., M.D.

THE roentgenological visualization of the bronchial tree by the introduction of a radiopaque material was first successfully employed in humans in 1918.[5] Since then a great many techniques have been described to improve or simplify this procedure. The recognition of lipiodol as an excellent radiopaque material for bronchography in 1921 was perhaps the first and greatest advance along these lines.[13]

The chief remaining difficulty has been in methods of securing adequate topical anesthesia with such agents as cocaine and pontocaine. Despite much investigation, this field has remained relatively static until the recent development of an aerosol technique and an aerosol anesthetic solution[7,8,9] which make the procedure simple, safe, and almost entirely free from discomfort.

The aerosol technique consists in having the patient simply inhale a mist of the nebulized solution. This is entirely different from the older method of atomization. Atomization (spraying) is the production of relatively large droplets which, when striking the pharynx, cause gagging and coughing. Nebulization is the production of a fine mist of suspended droplets of 5 micra or less in diameter which may be inhaled comfortably and carried by convection into the bronchial passages. From the standpoint of increased ease of administration, smaller amount of anesthetic solution required, and almost complete lack of discomfort to the patient, this is a great improvement on the standard techniques of atomization, swabbing, and tracheal instillation.

The early employment of this method of anesthesia in children convincingly demonstrated that, in order to evolve a single procedure that would be effective and applicable to patients of all ages, it would be necessary to occlude the external nares, generate the aerosol into the mouth in a continuous stream, have the patient hold his tongue forward with gauze, and attach to the nebulizer a rubber mouthpiece 3 inches long so that the point of delivery could be advanced toward the larynx as anesthesia progressed.

Further use of the technique disclosed occasional irregularities in the depth and distribution of anesthesia as well as in the time required for anesthetization. Pharyngeal and laryngeal anesthesia was regularly obtainable in less than twenty minutes, but tracheobronchial anesthesia was usually slower and less reliable. After a prolonged study of the factors involved, it became apparent that the difficulty was based on the extremely small size of the aerosol particles. The process of nebulization breaks the solution into millions of tiny particles, thus enormously increasing the surface area of the solution. This in turn causes the particles to evaporate at an extremely rapid rate. It has been shown that atomized particles of 10 micra and below completely evaporate within 0.02 second after production.[14] An aqueous aerosol can be observed to disappear completely within about 3 to 6 inches of the mouth of the nebulizer. Therapeutically, this results in a relatively small amount of deposition on the respiratory mucosa beyond the pharynx and larynx. The reduced size of those particles that are deposited results in a slow coverage of the mucosa, since a great many

* From a study originating in the Pediatric and Radiology Services of Sea View Hospital, Staten Island, New York; Bret Ratner, and A. V. Shapiro, Directors.

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of these tiny particles must be deposited before there is a sufficient number to coalesce and form a continuous film.

These difficulties are entirely overcome by adding the proper concentrations of glycerin and detergent to the solution. Abramson[1] contributed the significant fact that glycerin tends to hold on to the water in the droplet, thereby inhibiting evaporation and stabilizing particle size. This results in deeper penetration of the mist into the bronchial passageway. However, glycerin alone does not necessarily result in increased deposition, since the stabilized droplets tend to maintain their integrity and to rebound from obstructing surfaces. In fact, recent data demonstrate that strong glycerin solutions may actually deposit to a lesser extent than plain aqueous solutions.[12] An additional agent is required to lower the surface tension of the droplets, so that they may become disrupted on contact with obstructing surfaces, *i.e.*, to make them "splatter out" rather than bounce off. A surface-tension reducing agent thus causes increased deposition, coalescence of deposited droplets, and formation of a thin but widespread film of anesthetic solution over the mucosal surfaces. When both agents are added, the time required to obtain tracheobronchial as well as pharyngeal and laryngeal anesthesia is shortened and the depth and distribution of anesthesia are made uniformly excellent.*

The detergent employed in this solution is triton A-20. This is the most stable and least toxic detergent available for aerosol therapy, and the one on which the greatest background exists.[2,3,4,6,10,11] It is not precipitated by proteins or digested by tissue lipases as are most other detergents, and so retains it detergency even after being deposited on the tracheobronchial mucosa. Although it is physically active in lowering surface tension, it is chemically practically inert and therefore has a very wide margin of safety.

The phenomena described are real, and can easily be demonstrated objectively. The tendency to evaporation can be observed by visualizing the disappearance of the mist of an aqueous solution within 3 to 6 inches of the nebulizer orifice. The addition of glycerin to the solution results in the production of a dense mist that floats about in the atmosphere for many seconds or minutes. The spreading effect of triton A-20 can be demonstrated by nebulizing solutions of dyes with and without the detergent for one minute toward moist filter papers. The solution containing the detergent produces a deeply colored blotch of large size, whereas an aqueous solution produces a faint discoloration of small size, and a glycerin solution produces an even lighter-colored area of still smaller size.

Although cocaine is effective in this solution, the preferred anesthetic agent is pontocaine. In therapeutic concentration, it is less toxic and longer acting than cocaine and particularly safer for children. The concentration of pontocaine employed in this solution is 0.5 per cent. This is the minimal effective concentration to completely abolish the cough, gag, and swallowing reflexes. Higher concentrations are not employed as they are unnecessary and it is important that the total dose be as small as possible. The aerosol technique results in the deposition of about 15 per cent of the total amount nebulized,[7,8,9] *i.e.*, 1 cc. of 0.5 per cent pontocaine, which is a total dose of only about 5 milligrams. This is a relatively minute amount as compared to that of standard procedures (40–100 mg.) and is far below the recommended maximum dose of 20 mg.

With the perfected aerosol technique of anesthesia, we began to examine critically the methods reported in the literature for introducing lipiodol and filling the desired pulmonary lobes or segments for adequate roentgenologic visualization. The first question considered was: Is it sufficient

* This entire balanced solution is known as Pontocaine Hydrochloride Aerosol Solution and can be obtained from Winthrop-Stearns, Inc., 1450 Broadway, New York 18, N. Y.

to introduce the lipiodol into the pharynx and allow it to flow passively into the bronchial tree by gravity, or is direct tracheal or bronchial catheterization necessary?

Obviously, the passive method is easier to perform and less disturbing to the patient, and is therefore desirable if the flow of oil can be effectively directed into the desired areas. A study of bronchial anatomy resulted in the development of a very simple positioning procedure whereby the oil can be directed from the pharynx into the bronchial tree in such a way that the entire bronchial tree is filled. If the patient reclines and supports himself on one elbow, his head is thereby elevated about 30 degrees above the horizontal, and the oil which is introduced into the pharynx flows slowly into the trachea and larger bronchi. This results in a continuous stream of oil extending from the larynx to the lower lobe bronchi, rather than pooling of all the lipiodol in the lower lobe as would occur if the patient were sitting upright. Sufficient lipiodol remains in the trachea and main stem bronchus to be diverted into all the segmental bronchi by positioning.

The positioning is simplified by the fact that all lobar and segmental bronchi begin medially and run laterally, anteriorly, or posteriorly. In addition, some have a superior, and others an inferior angulation. Thus, the entire tree is filled by placing the patient in the lateral, prone, and supine position while the head is slightly elevated, and repeating these positions with the head lowered. The resultant filling of the bronchial tree of an entire lung is more desirable from the standpoint of total diagnosis than is the filling of a single lobe or segment by tracheal catheterization. It is also easier for the physician to perform and less disturbing to the patient, and can be performed blindly without roentgenoscopic or endoscopic control.

The control of flow rests chiefly with the positioning procedure. A few additional signs are of value in following the course of the lipiodol stream. One of these is the observation of the larynx or Adam's apple in the neck; if this remains steady, the lipiodol is not being swallowed and hence must enter the larynx. Secondly, a gurgling sound is usually heard, signifying that the lipiodol is passing over the vocal cords into the larynx; the cessation of gurgling indicates that the entire stream has entered the tracheobronchial tree. Thirdly, rhonchi can usually be felt by placing the hand on the patient's chest in the area of the lower lobe, indicating that the head of the oil column has reached the lower lobe bronchi. All these signs have usually occurred by the time sixty seconds have elapsed from the beginning of injection, and the rest of the positioning procedure and exposure of the roentgen film may then be performed. If a bilateral bronchogram is desired, it is simply necessary to repeat the instillation of lipiodol and positioning procedures for the other side.

Finally, it was felt desirable to attempt to find a way to remove the lipiodol from the lungs. Lipiodol is not irritating or harmful except in the rare case of iodine sensitivity, but its long continued presence may obscure the lung markings and make roentgenologic interpretation somewhat difficult for weeks or months. It has long been held to be contraindicated in pulmonary tuberculosis because of its iodide content, although a great deal of clinical evidence has accumulated to discredit this supposition except in acute forms of the disease.

At any rate, the rapid removal of lipiodol from the lungs is desirable and, in our experience, fairly easy to accomplish. This is done by starting postural drainage in the roentgen-ray room, as soon as the films have been exposed. At this time the lipiodol has not yet reached the alveoli and is still in the bronchial tree. By exhaling forcibly with the head low and refraining from coughing, the lipiodol stream is drained out of the trachea and lower and middle lobes before the patient leaves the roentgen-ray room. This requires about thirty minutes, and is usually incomplete if less time is allowed. At the end of thirty minutes,

the patient returns home or to his hospital bed. After the patient leaves the roentgen-ray room, the lipiodol remaining in the upper lobe drains downward due to the erect posture of the patient. After reaching his bed, the patient again lowers his head

air compressor) with gum-rubber tubing connecting to nebulizer.

3. Anesthetic solution (described above).

4. Adhesive tape, 1 inch wide, for occluding nostrils.

5. Gauze squares for holding tongue forward.

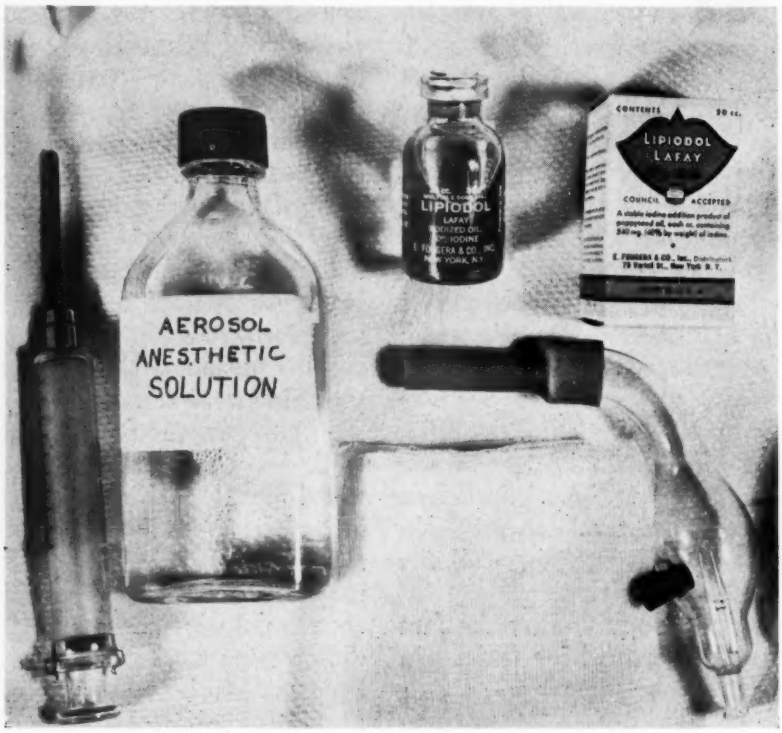

Fig. 1. Materials employed. Note that the only instruments required are the nebulizer and syringe. No endoscopic instruments are needed. (Reproduced by Permission from *J. Pediat.*, 1950, *36*, 721–727.)

for thirty minutes to complete the drainage procedure. This evacuates practically all of the lipiodol from the lungs, and the small amount remaining is absorbed in a few days.

Following is an outline of the technique and a few illustrative bronchograms:

OUTLINE OF PROCEDURE

Materials (Fig. 1).

1. DeVilbiss No. 40 nebulizer with rubber stopper in side vent, and with rubber mouthpiece 3 inches long and ½ inch in diameter attached to oral end of nebulizer.

2. Oxygen tank and gauge (or motor-driven

6. Forty per cent lipiodol, 20 cc. vial.

7. Syringe, 20 cc. with a 3 inch length of fine catheter tubing attached.

8. Tilt stretcher or tilt roentgenographic table.

Preoperative Orders (dosages appropriate for age).

1. Postural drainage on arising (if secretions are copious).

2. No breakfast and nothing by mouth.

3. Nembutal, two hours before bronchography.

4. Morphine or codeine sulfate
5. Atropine sulfate

} (½ hour before bronchography).

6. Postural drainage on return to ward or home, 30 minutes, once.

7. No food or fluids until ½ hour after bronchography.

Technique of Anesthesia (Fig. 2).

1. Introduce 8 cc. of anesthetic solution into the nebulizer and close the side vent with the rubber stopper.

2. Tape off the nostrils so that the patient must breathe through the mouth, and have him pull the tongue forward with a gauze square. Demonstrate the mist to the patient and have him hold the rubber mouthpiece of the nebulizer in his mouth and inhale the mist.

3. Use an oxygen flow of 6 liters per minute for the first 5 minutes while the patient inhales the mist; then continue at 10 liters per minute until the *entire solution* is nebulized.

4. During nebulization have the patient change the direction of the mouthpiece in such a way that he obtains a direct impact on the lateral walls of the pharynx as well as in the midline, and have him gradually advance the mouthpiece deeper into the pharynx as the anesthesia progresses.

5. Remove the adhesive tape from the nostrils, and have the patient disrobe to the waist in preparation for roentgen examination.

Technique of Lipiodol Administration (Fig. 3).

1. Have the patient lie on the tilt stretcher under the roentgen tube, with his feet at the adjustable end so that they can be elevated at the proper time, With the table horizontal, the patient lies on the side to be studied bronchographically, supporting himself on his elbow so that his body is in the lateral position and at an angle of about 30 degrees from the horizontal.

2. To prevent loss of time later, place the cassette under the patient and label it before the lipiodol is instilled.

3. Have the patient hold his tongue completely forward with gauze, and instruct him not to release it until just before the film is to be exposed. Caution him not to cough or swallow. If the patient is a young child, have an assistant hold the tongue.

4. Insert the catheter tip of the lipiodol syringe 2 or 3 inches into the mouth or nostril, being careful not to reach the esophagus, and inject the entire vial of lipiodol rapidly into the pharynx.

Fig. 2. Technique of aerosol anesthesia. The patient inhales the mist produced by the nebulizer. A complete surface anesthesia of the respiratory mucosa is thus obtained without discomfort to the patient or difficulty to the physician. (Reproduced by permission from *J. Pediat.*, 1950, *36*, 721–727.)

Fig. 3. The administration of lipiodol and the positioning employed. The first position (*A*) is maintained for sixty seconds to allow the lipiodol to pass the larynx. All other positions are maintained for twenty seconds each. Note the simplicity of the positions, the last three positions being duplicates of the first three except that the head is lowered. (Reproduced by permission from *J. Pediat.*, 1950, *36*, 721–727.)

a. The injection takes about 45 seconds, and the lipiodol gurgles for an additional few seconds as it passes through the larynx.

b. Now there is a continuous column of lipiodol extending from the larynx to the lower lobe; that stream will be diverted by positioning so as to enter the various branches of the bronchial tree.

5. Within 60 seconds after beginning the injection, the catheter is removed and the patient is turned to the prone position for 20 seconds, then to the supine position for 20 seconds. This fills the lower lobe, and the middle lobe on the right side or lingula on the left.

6. The foot end of the stretcher is immediately elevated to about 45 degrees and the pa-

Fig. 4. Postural drainage. This is begun immediately after exposure of the roentgen films, so that the lipiodol is evacuated before it is able to flow into the alveoli. (Reproduced by permission from *J. Pediat.*, 1950, *36*, 721–727.)

Fig. 6. Bronchiectasis in the apical segment of the right upper lobe.

Fig. 5. Bilateral bronchogram, illustrating the normal anatomy of the entire bronchial tree.

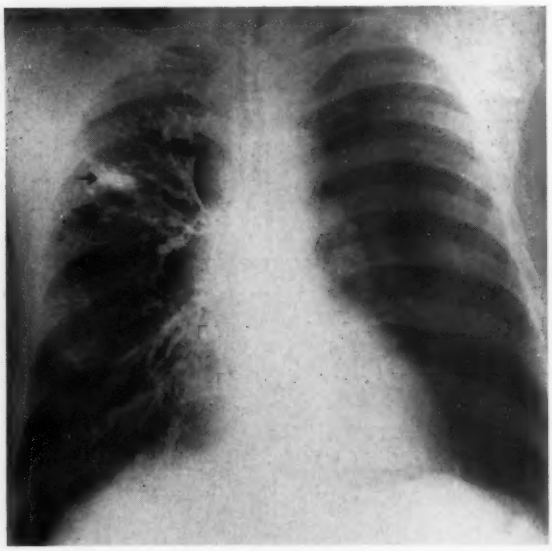

Fig. 7. Filling of an epithelialized tuberculous cavity in the right upper lobe.

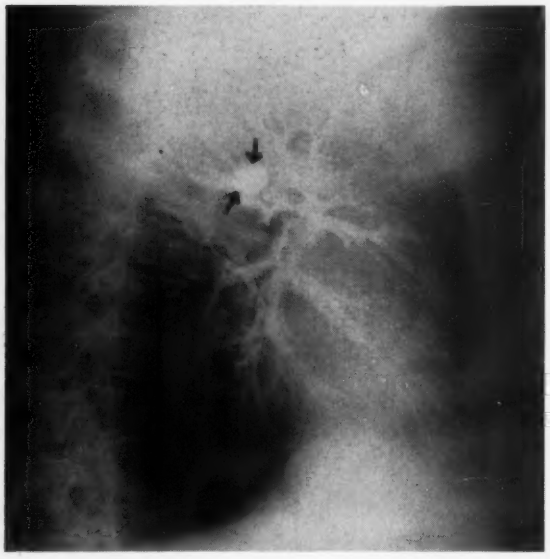

Fig. 8. Lateral view of same case as in Figure 7 reveals that the cavity is in the posterolateral segment.

tient positioned laterally, anteriorly, and posteriorly for 20 seconds each. This fills the entire upper lobe.

7. The films are then exposed. They are, in order:

a. Lateral.

b. Posteroanterior.

8. If the other lung is to be examined, another entire vial of lipiodol is instilled with the patient supporting himself on the other elbow. The positioning procedures are repeated for the second side, and the following exposures made:

a. Posteroanterior.

b. Both posterior obliques.

9. Postural drainage is begun immediately (Fig. 4) with forced tussive squeezing for 30 minutes (no coughing). This usually eliminates

Fig. 9. Bronchiectasis in the right middle lobe.

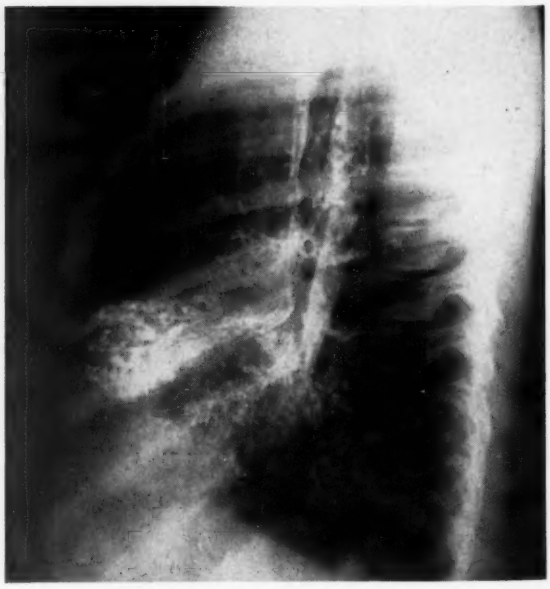

Fig. 10. Lateral view of same case as in Figure 9 reveals that the entire middle lobe is involved.

the lipiodol from the trachea and the lower and middle lobes.

10. The patient is returned to the ward or home, ambulatory, so that the lipiodol in the upper lobe drains downward. On arrival, he repeats the postural drainage once for 30 minutes.

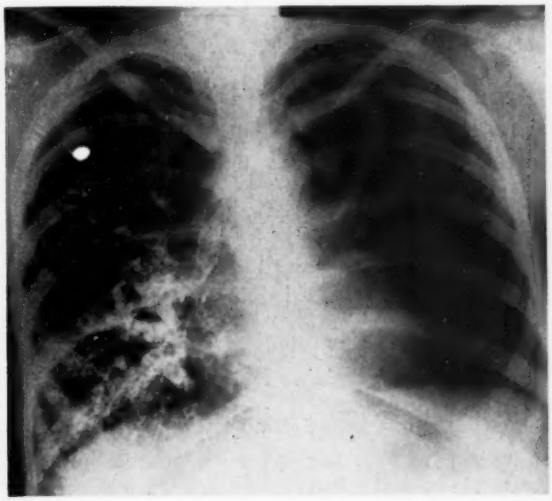

Fig. 11. Cystic bronchiectasis in the right lung.

Fig. 12. Lateral view of same case as in Figure 11 reveals that all segments of all lobes are involved.

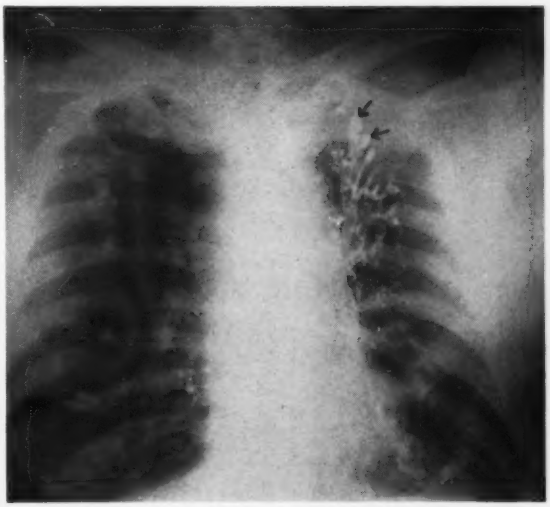

Fig. 13. Bronchiectasis of the apical portion of the apicoposterior segment of the left upper lobe.

Fig. 14. Bilateral bronchogram revealing that the right bronchial tree is normal, while the entire left bronchial tree is bronchiectatic. Note that a single large cyst occupies the entire left upper lung-field.

COMMENT

The technique described is very effective in obtaining bronchograms, particularly in children and apprehensive adults, as attested by the bronchograms illustrated (Fig. 5–16). It is relatively simple as it requires no roentgenoscopic or endoscopic manipulations, and the positioning procedure involves no complicated maneuvers. It is safer than conventional methods, as it utilizes much smaller amounts of ponto-

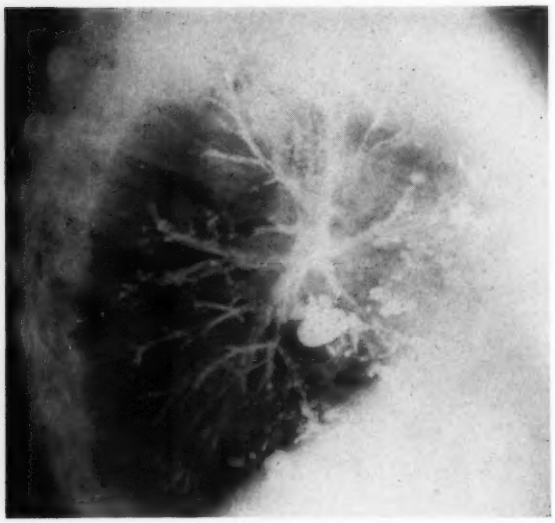

Fig. 15. Terminal bronchiectasis, in lateral view. The bronchi are fairly normal throughout their lengths, but are markedly dilated at their terminations.

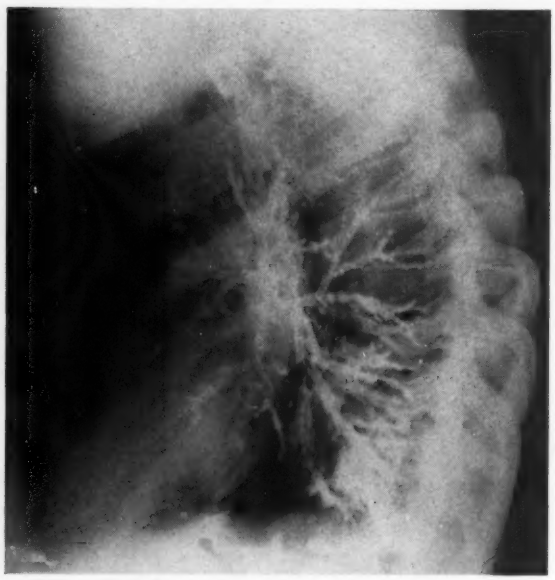

Fig. 16. Cylindrical bronchiectasis of the entire left lower lobe, in lateral view.

caine. Finally, it is almost entirely free of discomfort to the patient.

These factors make it a procedure of choice for the occasional bronchographist. In addition, the technique is easily adapted for the busy clinic by adding one or two Y-tubes to the oxygen or air line, thereby enabling 2, 3, or more patients to be anesthetized simultaneously. A cheap commercial air-compressor of the type used for paint spraying will produce sufficient pressure to operate four to eight nebulizers simultaneously. Thus, one trained assistant can handle all the anesthetizations, supplying the physician with an anesthetized patient every few minutes.

SUMMARY

A new technique of bronchography is described which has the advantages of increased simplicity and ease of performance, and increased comfort and safety for the patient. It is not only the procedure of choice for the occasional bronchographist but, with the addition of a small amount of equipment, for the busy clinic as well.

We are deeply indebted to Dr. H. A. Abramson for advice and guidance in the application of basic aerosol techniques.

We are grateful to Dr. J. B. Rice of Winthrop-Stearns, Inc., for supplying the pontocaine hydrochloride aerosol solution; to Mr. Phillip Bonesteel of the DeVilbiss Company for supplying the DeVilbiss No. 40 nebulizers; and to Mr. Clifford Bradney of Fougera, Inc., for supplying the lipiodol used in this study.

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EVALUATION OF A FIVE YEAR MINIFILM PROGRAM*

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A FIVE year Mobile Unit roentgen study has been completed in the County of Vanderburgh, State of Indiana. The unique features of this survey are: (1) the project was continuous; (2) the operation of the unit and the follow-up was carried on by the same organizations; (3) stereoscopic roentgenologic interpretation permitted prognostication of both active and inactive lung lesions; (4) the project was self-supporting.

The Mobile Unit, the salaries of the personnel and all other official assistance were financed by money collected at the rate of $1.50 per film. The intial cost of the unit and its upkeep was liquidated during the five year period. Tuberculosis associations in adjacent counties contributed to the support of the Unit by conducting periodic surveys. The individuals roentgenographed in these counties are not included in this report.

The majority of those roentgenographed were industrial employees. High school groups, city block and township surveys were taken free of charge (1) in order to compare the charge method with the so-called free method, and (2) to ascertain whether, because of the charge method, we were missing any segment of the population which might have a high incidence of tuberculosis. Particular attention was paid to food handlers in restaurants, drug stores, and taverns, since they have the highest incidence of tuberculosis of any group in the city.

A total of 70,877 individuals were roentgenographed and many were rechecked in hospitals, clinics and offices of private physicians. In addition, 5,599 of the 70,877 were re-roentgenographed on the Mobile Unit. Stereoscopic 4 by 10 inch films were used for each person, which greatly facilitated the diagnosis and aided subsequent recommendations. Gastric analyses and cultures were employed in checking all suspects and, thus, this series should be noted for the absence of a suspect group.

Technically, each person whose roentgenogram is positive or negative should have a gastric analysis and culture to rule out tuberculosis. This is a Utopian impossibility due to lack of funds and especially individual cooperation. It was necessary to re-roentgenograph about 1 person per 1,000 on 14 by 17 inch film, which corroborates our contention that a 4 by 10 inch film is more than just a screen film. Other surveys report re-roentgenograms required on 14 by 17 inch film of 10 to 30 per 1,000 on 70 mm. and 60 per 1,000 on 35 mm. film. Cleveland, in taking 684,763 roentgenograms on 70 mm. film, ordered 16,219 size 14 by 17 inch films.

ANALYSIS OF DATA

Of the 70,877 persons roentgenographed, 59,716 (84.0 per cent) were negative for reinfection type of pulmonary tuberculosis; 8,251 (11.0 per cent) had pulmonary calcification; 2,910 (4.1 per cent) had reinfection type of pulmonary tuberculosis (active or inactive) (Table 1). Of the 70,877 individuals roentgenographed, 2,866 (4.04 per cent) were inactive (Table II); 2,643 were minimal; 216 were moderately advanced and 7 were far advanced. Forty-four (0.06 per cent) had active pulmonary tuberculosis—a ratio of 2/3 of 1 per 1,000. Of the 44 active cases, 17 were minimal; 19 were moderately advanced, and 8 were far advanced. Altogether, 13,391 (18.0 per cent) had some abnormality of the lungs, heart or thoracic cage; 8,251 (11.0 per cent) had pulmonary, glandular or pleural calcifications which lesions were not considered significant. There was no attempt

* From Boehne Tuberculosis Hospital and the Vanderburgh County Tuberculosis Association, Evansville, Indiana.

made to differentiate between nontuberculous and tuberculous calcification, since this would be conjecture to do so without proper skin testing and differential diagnosis.

Two thousand, two hundred and thirty (2,230) individuals showed other abnormalities (Table III), of which the more important are listed as follows: 733 had probbable heart or aortic abnormalities, as indicated by size and shape only; 116 had congenital rib defects; 105 had azygos lobes; 30 had substernal thyroids; 29 had a foreign body in the lung or chest wall; 28 had silicosis; 23 had bronchiectasis; 9 had lung or mediastinal tumors; 4 had congenital cystic disease of the lung. Other conditions were: spine deformities, atelectasis, emphysema, pleurisy, pneumonitis and pulmonary fibroses in locations other than the upper third of the lung fields. However, residual fibrosis which occurs after the invasion of acid fast bacilli may occur in any lung segment.

A detailed study of the last 28,606 films in this series (Table IV) revealed a ratio of 50 cases of significant (active or inactive) pulmonary tuberculosis per 1,000 films among food handlers; 38 cases per 1,000 films in industry; 29 per 1,000 in the general population and only 10 cases per 1,000 films among high school and college students. The ratio of active cases per 1,000 films was higher among food handlers with 1.1 cases per 1,000 films as against 0.4 cases per 1,000 films in the general population and 0.6 cases per 1,000 films in industry groups. No active cases were noted in the student group.

EVALUATION OF DATA

(A) *Active Cases per Death.* Vanderburgh County has a population of approximately 160,000. If the present findings on 70,877 people were projected for the entire population, one would expect to find in a complete roentgen-ray survey a total of 96 (0.062 per cent) active cases in this county. During the five year period of this survey, the average number of deaths in Vander-

Table I

SUMMARY OF 70,877 MOBILE UNIT ROENTGENOGRAMS 1944–1949

	NUMBER OF PERSONS	PER CENT OF PERSONS X-RAYED	CASES PER 1000 PERSONS
PERSONS NEGATIVE FOR REINFECTION TYPE PULMONARY TUBERCULOSIS	59,716	84.25	842.5
PERSONS WITH PULMONARY CALCIFICATION (TUBERCULOUS AND NON-TUBERCULOUS)	8,251	11.64	116.4
PERSONS WITH REINFECTION TYPE PULMONARY TUBERCULOSIS (ACTIVE AND INACTIVE)	2,910	4.10	41.0
TOTAL	70,877	100.0	1000.0

Table II

PERSONS WITH SIGNIFICANT REINFECTION TYPE PULMONARY TUBERCULOSIS

	NUMBER OF PERSONS	PER CENT OF PERSONS X-RAYED	CASES PER 1000 PERSONS
ACTIVE			
MINIMAL	17	0.024	.24
MODERATELY ADVANCED	19	0.026	.26
FAR ADVANCED	8	0.01	.11
TOTAL ACTIVE CASES	44	0.06	.6
INACTIVE			
MINIMAL	2,643	3.72	37.2
MODERATELY ADVANCED	216	0.304	3.04
FAR ADVANCED	7	0.009	.09
TOTAL INACTIVE CASES	2,866	4.04	40.4
GRAND TOTAL REINFECTION TYPE	2,910	4.10	41.0

Table III

PERSONS WITH OTHER CHEST PATHOLOGY AND ABNORMALITIES

	NUMBER OF PERSONS	PER CENT OF PERSONS X-RAYED	CASES PER 1,000 PERSONS
AZYGOS LOBE	105	.14	1.4
BRONCHIECTASIS - PROVEN	23	.032	.3
CONGENITAL CYSTIC DISEASE OF LUNG	4	.004	.04
CONGENITAL RIB ABNORMALITY	116	.16	1.6
FOREIGN BODY IN LUNG OR CHEST WALL	29	.04	.4
HEART AND AORTA	733	1.03	10.3
SILICOSIS	28	.039	.3
SUBSTERNAL THYROID	30	.042	.4
TUMORS	9	.012	.1
MISCELLANEOUS	1,153	1.62	16.2
TOTALS	2,230	3.14	31.4

burgh County was 44 per annum. If we were to utilize the old ratio of 9 cases per death, we would find in Vanderburgh County 396 active cases. Moreover, if the Mobile Unit figures of 96 active cases per year are used, we would have a ratio of between 2 and 3 active cases per death. During the last five years the City-County Health Department has recorded an average of 96 new cases of tuberculosis per annum. This corroborates the Mobile Unit projection finding.

Table IV

Group analysis of the last 28,606 films

X-ray findings	Industry			Food handlers			Students			General population			Total		
	Number	Per cent	Ratio per 1000 films	Number	Per cent	Ratio per 1000 films	Number	Per cent	Ratio per 1000 films	Number	Per cent	Ratio per 1000 films	Number	Per cent	Ratio per 1000 films
Total number of films	12,304			5,845			5,347			5,110			28,606		
Negative films	10,559	85.8	858	5,026	85.9	859	4,872	91.1	911	4,551	89.06	890	25,008	87.4	874
Pulmonary calcification (tuberculous and non-tuberculous)	1,271	10.3	103	521	8.9	89	419	7.8	78	406	7.9	79	2,617	9.1	91
Reinfection type pulmonary tuberculosis (active and inactive)	474	3.8	38	298	5.0	50	56	1.0	10	153	2.9	29	981	3.4	34
Active reinfection pulmonary tuberculosis	8	.06	0.6	7	0.1	1.1	0	0	0	2	.04	0.4	17	.06	0.6
Inactive reinfection pulmonary tuberculosis	466	3.7	37.8	291	4.9	49.7	56	1.0	10.4	151	2.9	29.5	964	3.3	33.7

(B) *Number of Inactive Cases.* If all the inactive cases, so diagnosed by roentgenographic findings, were at one time cases of active tuberculosis, this survey reveals a total of 2,866. If this survey had included the entire population of 160,000, we would expect to find approximately 6,464 inactive cases of pulmonary tuberculosis, or at least 6,464 individuals who demonstrated in their roentgenograms pulmonary fibrosis, infiltration and calcified areas, chiefly in the upper third of one or both lungs. However, since there is no laboratory or clinical proof that these fibrotic areas represent healed tuberculous lesions, one must consider the films to be overread. Nevertheless, it must be remembered that many tuberculous lesions resolve completely, or become masked and finally exhibit an absence of roentgenographic evidence in the average posteroanterior view. In 1940,[1] 1,000 adults in this area were checked by 14 by 17 inch film and two strengths of tuberculin. Twenty-three per cent had negative roentgenograms and positive tuberculin. These individuals might counterbalance the overreading of those who had nonspecific pulmonary markings. In this survey all individuals were notified that they had probable lesions of tuberculosis and should be checked periodically. A few were alarmed but all gained pertinent information about tuberculosis. If this survey had included the entire population of 160,000, we would except to find 6,400 (4.0 per cent) inactive cases. On this basis the ratio of the average number of deaths per year (44) to the inactive cases equals 145 per death.

(C) *Number of Cases of Calcification.* We found 8,251 individuals out of 70,877 who had roentgen evidence of pulmonary calcification. However, in 1941,[2] 1,556 Evansville high school freshmen were roentgenographed on 14 by 17 inch films and tested with two strengths of tuberculin (PPD); 307 had roentgen findings of pulmonary calcification, of which 205 (66.0 per cent) did not react to either strength of tuberculin. If this percentage of 66.0 per cent were projected to the 18,624 individuals with calcification, 12,291, or 7.69 per cent, of 160,000 might have nontuberculous calcifications. This would leave 6,333, or 4.0

per cent, of 160,000 with pulmonary calcifications which were tuberculous. If this is compared to the average number of 44 deaths per annum, a ratio of 145 cases of tuberculous calcification per death is obtained.

used 35 mm. and 70 mm. and 1 had used 70 mm. and 4 by 5 inch).

As indicated by Table v, the active cases of reinfection type pulmonary tuberculosis varied among these surveys from a low ratio of 0.3 cases per 1,000 films, to the

Table V

COMPARATIVE RESULTS OF SIXTEEN MINIFILM SURVEYS

LOCATION OF SURVEY	NUMBER OF FILMS TAKEN	ACTIVE CASES REINFECTION PUL. TBc.		INACTIVE CASES REINFECTION PUL. TBc.	
		PER CENT	PER 1000	PER CENT	PER 1000
CANADA					
PROVINCE OF ONTARIO	256,676	0.06	0.66	0.16	1.6
GEORGIA					
MUSCOGEE COUNTY	46,743	0.3	3.01[1]	1.09	10.9[1]
ILLINOIS					
WILL COUNTY (JOLIET)	39,809	0.09	0.9[2]	NOT AVAILABLE	
INDIANA					
ALLEN COUNTY (FT. WAYNE)	46,692	0.08	0.81	0.03	0.32
LAKE COUNTY (GARY)	100,623	0.27	2.7	0.57	5.7
MARION COUNTY (INDIANAPOLIS)	103,016	0.09	0.97	0.41	4.1
STATE OF INDIANA (EVANSVILLE EXCLUDED)	423,980	0.12	1.2	0.25	2.5
MINNESOTA					
ST. LOUIS COUNTY	179,094	0.10	1.07	1.34	13.4
ST. PAUL	169,392	0.03	0.33[3]	0.56	5.6
MISSOURI					
ST. LOUIS COUNTY (ST. LOUIS)	286,016	0.07	0.7[3]	NOT AVAILABLE	
NEW JERSEY					
BERGEN COUNTY (HACKENSACK)	52,419	0.10	1.01	0.66	6.6
NEW YORK					
QUEENSBORO	85,867	0.19	1.9	0.82	8.2
OHIO					
CUYAHOGA COUNTY (CLEVELAND)	684,763	0.046	0.46[3]	0.28	2.8
PENNSYLVANIA					
ERIE	101,522	0.09	0.9	0.38	3.8
U.S. PUBLIC HEALTH SERVICE					
BOSTON, MINNEAPOLIS, SALT LAKE CITY	992,805	0.09	0.9	0.5	5.0
TOTAL OF FIFTEEN SURVEYS	3,569,417	0.093	0.93	0.455	4.55
VANDERBURGH COUNTY, INDIANA (EVANSVILLE)	70,877[4]	0.06	0.6	4.04	40.4

[1] RESULT OF 3 YR. FOLLOW-UP IN WHICH PER CENT OF ACTIVITY INCREASES WITH LENGTH OF FOLLOW-UP.
[2] PRESUME ALL FINDINGS LISTED FOR WILL COUNTY, ILLINOIS ARE ACTIVE.
[3] REPRESENTS ACTIVE CASES NOT PREVIOUSLY KNOWN TO HEALTH AUTHORITIES.
[4] FIGURE REFERS TO INDIVIDUALS, NOT FILM.

COMPARATIVE RESULTS OF 15 SURVEYS

In order to compare findings (Table v) of the Vanderburgh County, Indiana survey with results of other surveys[4] conducted during the same period of time, a total of 31 organizations were contacted by questionnaire. Replies were received from 23, of which the data furnished by 15 could be used for comparison. In practically all of the 15 surveys 70 mm. film had been used (1 had used 35 mm., 1 had

high ratio of 3.01 cases per 1,000 films. Eight surveys reported active cases within a range of 0.81 to 1.2 cases per 1,000 films. The highest report came from Muskogee County, Georgia, with a ratio of 3.01 cases per 1,000. This ratio may reflect the results of a three year follow-up program. The surveys, with ratios in the lower bracket for the most part, reported new cases which were not previously known to the survey authorities. Several surveys reported a great many films still classed as

"suspect," "questionably active," or "activity undetermined"; in some cases several years elapsed after the completion of the survey proper.

The ratio of inactive cases of reinfection pulmonary tuberculosis per 1,000 films was figured for only 13 of the other surveys, as 2 of them did not give results in this category. The ratio of inactive cases per 1,000 films varies from a low of 0.32 per 1,000 films to a high of 13.4 per 1,000 films. Seven surveys report ratios varying from 2.5 to 5.7 per 1,000 films. The highest ratio, 13.4, comes from a survey in St. Louis County, Minnesota. The next highest ratio, 10.9, comes from Muskogee County, Georgia, after a three year follow-up study. The Vanderburgh County ratio of 40.4 cases of inactive reinfection pulmonary tuberculosis per 1,000 individuals is almost 3 times as great as the highest of the other surveys studied, and about 8 times as high as most of the other surveys.

Since this has been a continuous five year survey, and with a period of two years elapsed since the last film was taken, we have had an opportunity to prove or disprove initial roentgen diagnoses. For example, one individual had a negative roentgenogram in October and a moderately advanced case of active reinfection pulmonary tuberculosis six months later. Another individual had a negative roentgenogram in May and a bronchogenic carcinoma five months later. The patient insisted that he had no symptoms at that time. One person who was diagnosed as tuberculosis (activity to be determined) had a squamous cell carcinoma, so determined by cellular examination of the bronchoscopic specimen.

PERCENTAGE OF ERROR

Garland[3] states that the percentage of error of inter-individual comparison of films averages 16.0 per cent, while intra-individual comparison averages 8.0 per cent. In this series all films were read by the same individual. All films with abnormal findings were reread.

To date, two years after the five year survey, no serious mistakes have been noted. However, several opinions are more desirable than a single opinion, and consultation will portray errors and alter presumptive diagnostic adjustments. Since the survey is lacking in comparative opinion, an 8.0 per cent error should be deducted for the dearth of individual comparison, except in the active case group which was confirmed by laboratory evidence. Even with an error deduction, this survey gives a fairly accurate picture of the actual and potential chest pathology which exists in the population of this area. Inter-individual comparison errors can be reduced by radiologists and chest specialists if they agree upon uniform definitions and interpretations of roentgen-ray markings.

DISCUSSION

From this study, it is evident that continuous roentgenographing, year after year, is essential for an adequate case-finding program, since tuberculosis is a periodic breakdown infection. Continuous roentgenographing develops continuous education and continuous follow-up, which cannot be achieved if a roentgen-ray program is offered periodically, or if one organization, under one direction, is responsible for taking the roentgenograms and another organization, under another direction, is responsible for the follow-up program. "Flash in the pan" or mass roentgenography of the entire population is too expensive and yields a belated deficit in case-finding, especially if the inactive cases of tuberculosis are overlooked. Furthermore, if it takes several years to follow-up a single survey, this lapse of time allows the active case to remain an infection menace to society. We likewise discovered that "street corner x-raying" may be good advertising, but it combines an inadequate pre-education program with a cumbersome post-follow-up program. Such procedures only prove to be balm for the conscience, of trying to do something publicly for tuber-

culosis. Continuous roentgen-raying and follow-up among groups which have a high incidence of tuberculosis not only gives publicity, but an adequate yield in active and inactive cases. If every food handler and domestic in Vanderburgh County were roentgenographed annually, the morbidity or mortality rates for the entire county would be greatly diminished within ten years.

An adequate roentgen-ray program must not only find the active case, but it must locate, as far as possible, the inactive cases who may later develop into active cases of tuberculosis. Many minimal cases of tuberculosis heal and later break down without knowledge of its previous existence. This group of inactive cases accounts for the large number of moderately advanced and far advanced cases which now reside in our sanatoriums. We will never diminish the group of far advanced cases unless we locate them in the inactive minimal stage, as well as the active minimal stage.

The $1.50 charge did not detract from the efficiency of this program. The individual, or the industrial plant who received the benefit of the roentgenogram, paid for the roentgen examination. The taxpayers' money was saved for the isolation and hospitalization of the active cases.

Only individuals who belonged to the group which contracted for the Mobile Unit services received roentgenograms. The members of an employee's family were not entitled to a roentgen ray on the Mobile Unit. They were referred to private physicians, clinics, hospitals and roentgen laboratories. If they could not afford this, they were referred to the Chest Clinic at Boehne Tuberculosis Hospital. Wherever possible, the roentgen report on all positive findings was mailed directly to the family physician. A letter was sent to each individual who had a positive finding, with the advice that he visit his physician. All persons who had negative films were so advised. In this way the Vanderburgh County Tuberculosis Association enlisted the cooperation of the entire medical profession, without whose support a program of this character becomes just a futile effort.

Suffice it to say, this program proves that volunteer organizations can own a Mobile Unit and operate a continuous roentgen-ray program. This permits our State and Federal Governments to spend their time making roentgen-ray surveys in areas which cannot afford to conduct a survey. And, a pay-as-you-go roentgen-ray program is proven to be just as effective, if not more so, than a free program.

SUMMARY

1. Of 70,877 individuals roentgenographed on 4 by 10 inch stereoscopic minifilm, 59,716 (84.0 per cent) were negative for re-infection type of pulmonary tuberculosis; 2,910 (4.0 per cent) had reinfection type of pulmonary tuberculosis; 2,866 (4.04 per cent) had inactive disease (presumptive by roentgen examination) while 44 (0.06 per cent) had active disease.

2. Thirty-one and four-tenths (31.4) cases per 1,000 showed other chest pathology and abnormalities. Among the more important were: heart and aorta, 10.3 per 1,000; azygos lobe, 1.4 per 1,000; substernal thyroid, 0.4 per 1,000; lung tumors, 0.1 per 1,000; congenital cystic disease, 0.04 per 1,000.

3. If the findings on 70,877 individuals are projected over the entire population of 160,000 of Vanderburgh County, it is logical to assume that there is approximately 0.6 of 1 active case of pulmonary tuberculosis per 1,000; 40 cases of tuberculous calcification per 1,000; 40 cases of inactive pulmonary tuberculosis (presumptive by roentgen examination) per 1,000; 76 cases of nontuberculous calcification per 1,000.

4. If the findings on 70,877 persons are projected for the entire population of 160,000 of Vanderburgh County, we find a ratio of 2.2 active cases per death, and a ratio of 145 inactive cases per death (presumptive by roentgen examination). The location and education of the inactive

case is just as important as the isolation of the active case.

5. Comparative findings with fifteen other surveys are analyzed.

6. Continuous roentgenography in groups with high incidence of tuberculosis is advocated, rather than periodic mass roentgenography of the entire population.

7. The Vanderburgh County study demonstrates that surveys can be made efficient, self-supporting and without assistance of either State or Federal Government monies.

The author wishes to express his deep appreciation to Mr. Charles D. Lineback, Executive Director of the Vanderburgh County Tuberculosis Association, for his valuable assistance in the preparation of this paper.

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A ROENTGEN EVALUATION OF VERTEBRAL FRACTURES RESULTING FROM CONVULSIVE SHOCK THERAPY*

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FRACTURES of the bodies of the dorsal spine occurring during convulsive shock therapy are frequent and the proper evaluation of their immediate and future significance is important. Before sufficient experience had been accumulated this complication was considered by some to be of serious import,[16] and the value of a therapeutic measure resulting in such dire consequences was questioned. It is our purpose to present the roentgen findings in a group of cases examined at intervals for two to four years after the initial fractures.

The first report of a convulsion therapy fracture appeared in the literature in 1938,[22] and since that time there have been several statistical analyses. The incidence of fractures varies widely and apparently depends upon the medium used to induce shock. Much of the early work was based upon metrazol induced shock and as high as 47 per cent[3] of these cases suffered fractures. The use of curare to diminish the severity of the convulsions produced by metrazol reduced the number of fractures to about one-fourth.[9] A further reduction was noted with electroshock and in a group of 252 cases so treated only 4.3 per cent revealed fractures.[11]

A single vertebral body may be fractured but involvement of several bodies is the usual finding. Although the commonest grouping of fractures appears to be D-4, D-5 and D-6,[13,14] the bodies immediately above and below these levels are frequently affected. A single body within a group may escape injury and remain intact. Fractures below the level of D-8 are not uncommon and occasionally the lumbar bodies are injured. We have not observed any fractures of the first dorsal body or the cervical spine.

There is no apparent correlation between the number of convulsions and the number of vertebrae affected. The phase of the convulsion during which the trauma occurs, as well as the actual mechanism of the fractures, has been the subject of considerable speculation. The intensity, duration and direction of the forces applied to the spinal column must obviously be the underlying factors.[7] Anatomically the segment of the spine from D-3 to D-8 is most vulnerable, due to powerful musculature operating through an area of minimal flexibility. During a typical convulsion the spine is partially flexed in the clonic phase and hyperextended in the tonic phase. The degree of flexion is far short of the jackknife position associated with the ordinary traumatic type of compression fracture involving the dorsolumbar junction and lumbar spine. Nevertheless the usual assumption is that the flexion part of the convulsion is responsible.[1,4,17,18,19] Although hyperextension fractures are considered to be extremely rare,[12] Webb[23] believes that it is during the tonic phase, when the spine is hyperextended, that the muscular contractions assume their maximum violence and the fractures probably occur. Brailsford[5] classifies the injury as disc repercussion fractures. He believes that the disc surfaces are hammered by rapidly repeated blows, the greatest amount of force being exerted in the least mobile portion of the

* From the Department of Roentgenology, Veterans Administration Hospital, Coatesville, Pennsylvania. Published with permission of the Chief Medical Officer, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the author.

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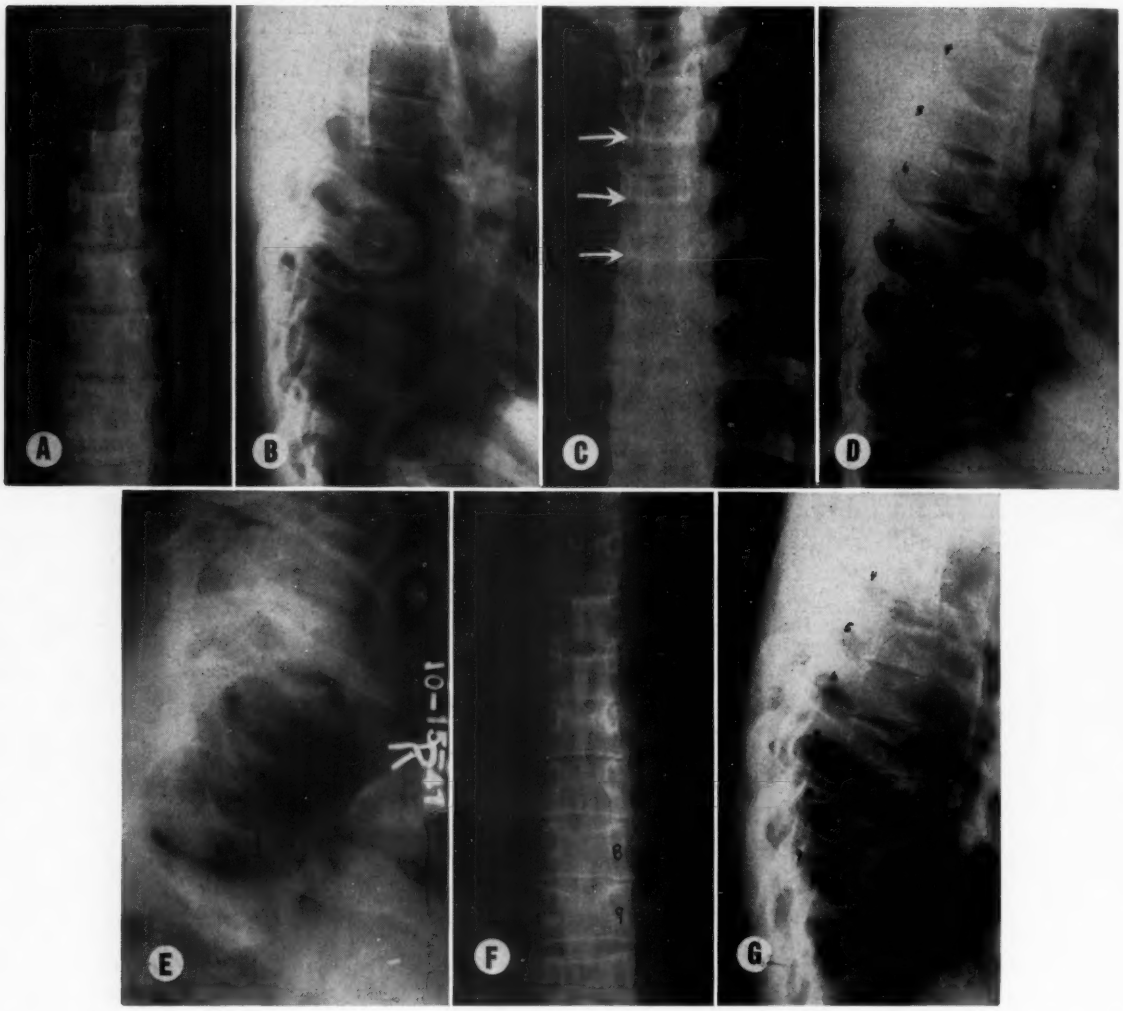


Fig 1. Male, aged twenty-five. Dorsal spine prior to shock therapy. (*A*) Frontal exposure. (*B*) Lateral exposure. Mild backache after shock therapy. (*C*) Frontal exposure demonstrates slight concavities of upper surfaces of bodies of D-2 to D-9 inclusive. Fracture of D-2 not definite on this view. Zones of increased density just below the surfaces are clearly seen (arrows). (*D*) Lateral exposure shows typical mild fractures with central depressions and subarticular density due to crushing of spongy bone. No anterior wedging. Narrowing of interspaces is apparent. (*E*) Lateral exposure for adequate visualization of upper segments of dorsal spine. Fracture of D-2 well demonstrated. (*F*) Frontal exposure twenty-four months later. Zones of increased density have disappeared and slight concavity of upper surfaces of several bodies remains. Residual minimal irregularity of upper surfaces of D-8 and D-9. No scoliosis. (*G*) Lateral exposure at this time demonstrates residual depressions of upper surfaces to better advantage than frontal exposure. Narrowed interspaces persist and there are typical Schmorl's nodes in D-7 and D-9. No progressive wedging, kyphosis or hypertrophic spurs.

vertebral column, resulting in compression of the superior borders of the vertebral bodies.

According to most reports, the presence of osteoporosis renders the bodies more susceptible to fracture. This may be true in severe degrees of osteoporosis but in the milder types our experience has not confirmed this assumption. The strong musculature of males is also cited as a predisposing factor.[2,8] Old fractures, arthritis, scoliosis and kyphosis are not considered contraindications to shock therapy.

Fresh fractures may be classified arbitrarily as mild, moderate and severe. The large majority are of the mild variety in

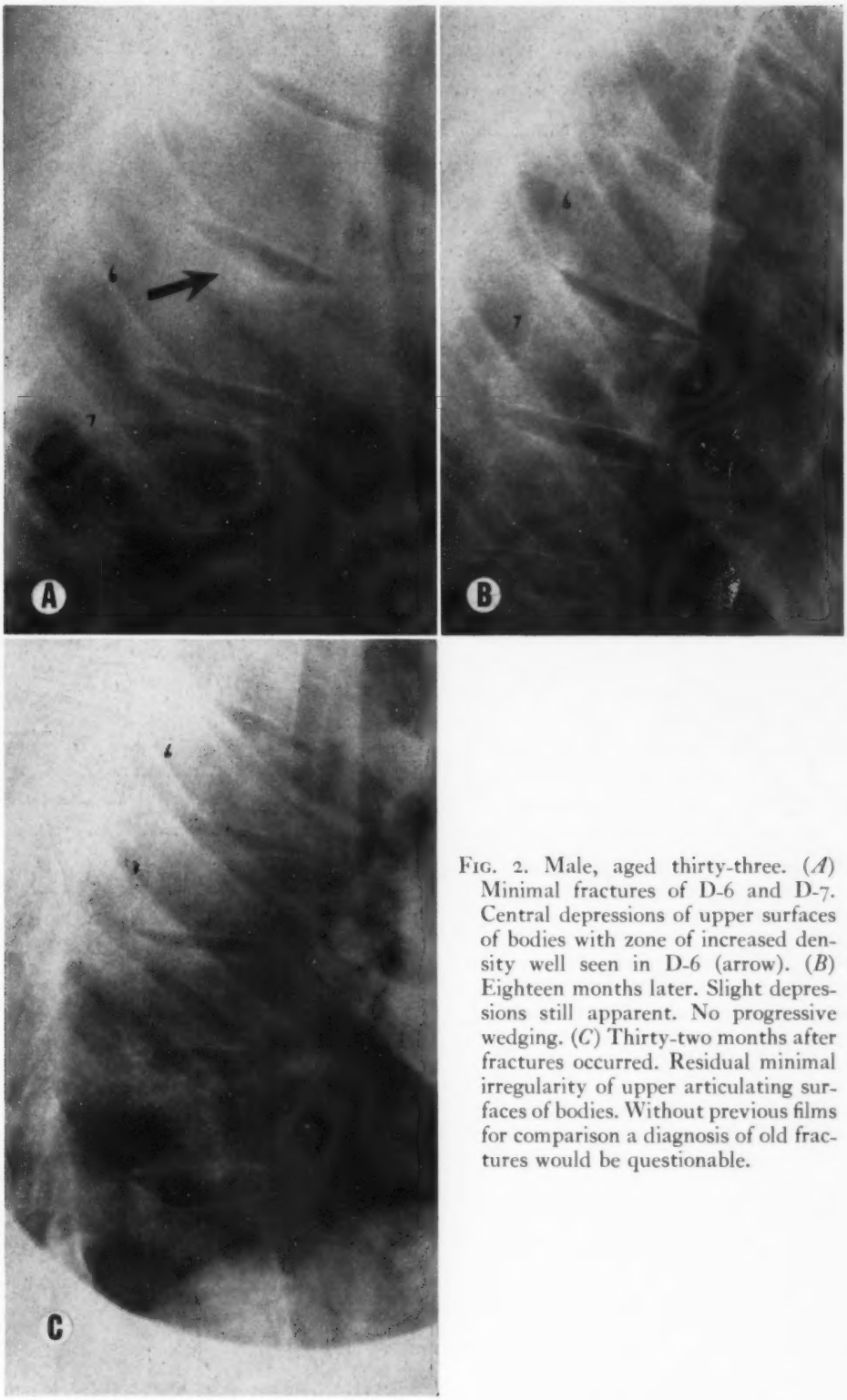


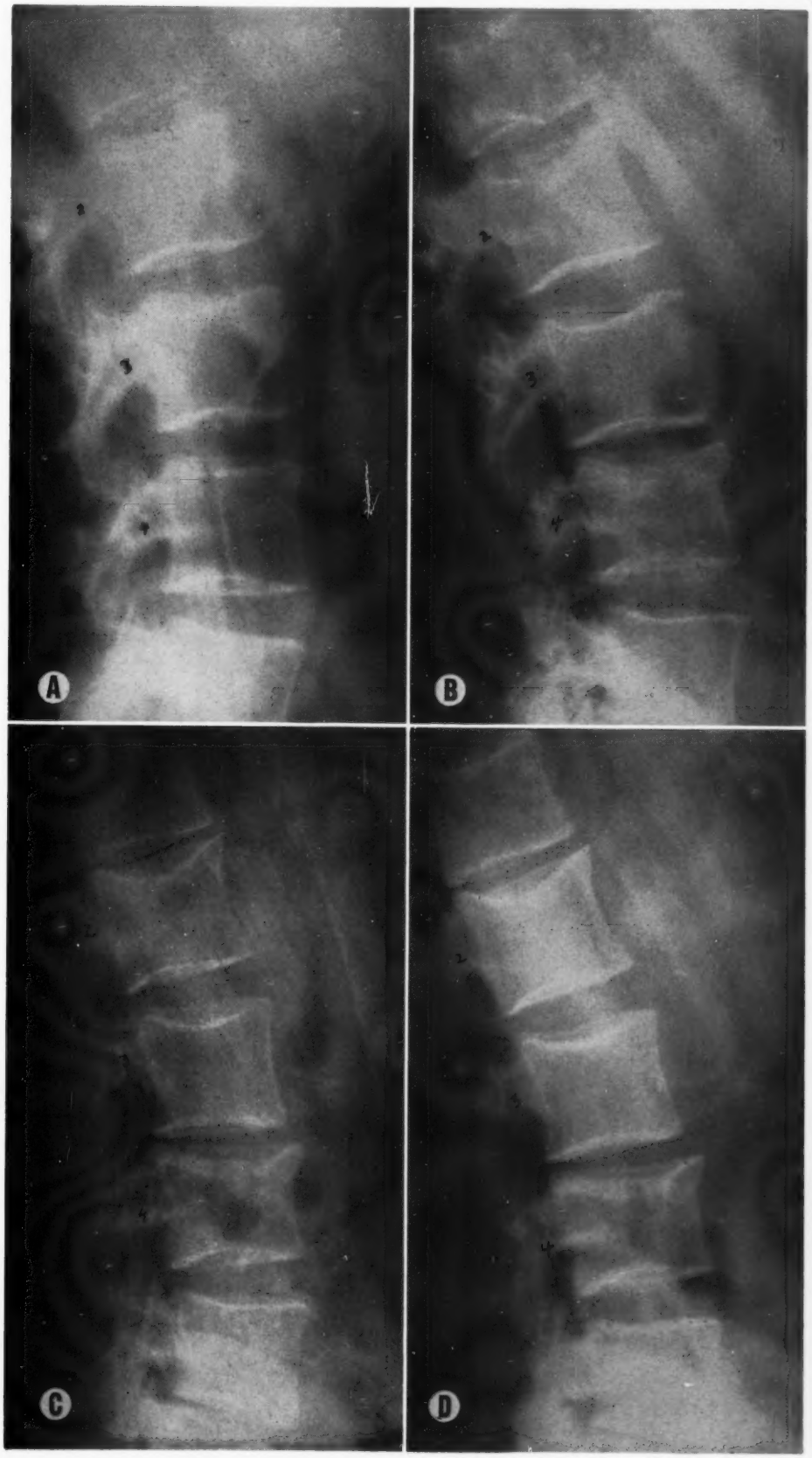
Fig. 2. Male, aged thirty-three. (*A*) Minimal fractures of D-6 and D-7. Central depressions of upper surfaces of bodies with zone of increased density well seen in D-6 (arrow). (*B*) Eighteen months later. Slight depressions still apparent. No progressive wedging. (*C*) Thirty-two months after fractures occurred. Residual minimal irregularity of upper articulating surfaces of bodies. Without previous films for comparison a diagnosis of old fractures would be questionable.

which there is merely a slight depression of the middle portion of the upper articulating surface of the body associated with a narrow zone of increased density just below the surface. The zone of increased density is due to impaction of the spongy bone and a definite fracture line is not usually visible. Frequently these changes can be seen with certainty only on the lateral exposures. Narrowing of the intervertebral space occurs when the cupping of the upper surface is prominent, suggesting partial herniation of the nucleus pulposus into the body. This diminution in width appears to be more common in the convulsion type fracture than in the usual compression fracture in which preservation of the disc space is fairly characteristic. The explanation by Brailsford of the disc repercussion fracture seems to apply particularly well to these mild fractures. Next in degree of severity are the fractures producing compression of the anterior portions of the bodies with slight wedging. Fracture lines along the upper articulating surfaces may be clearly seen. The posterior surface of the body which derives considerable support from the intervertebral joints is rarely involved.[21] The most severe cases show marked wedging with transverse elongation of the body resembling the ordinary traumatic compression fractures. In these the inferior surfaces of the bodies may be involved. Hyperflexion of the spine would certainly seem to be a major factor in the production of those fractures demonstrating any appreciable degree of anterior wedging.

During the early days of shock therapy vertebral fractures were considered to be a serious complication, with the possibility of future arthritis, deformity and disability. As more experience was gained, however, there was little indication of important sequelae. Worthing and Kalinowsky[24] observed 8 patients for two years after multiple fractures and concluded that there were no progressive pathological changes. Roberg[20] has described similar fractures in tetanus. In his group of 45 cases of tetanus, fractures were demonstrable in only 13. Despite this, all of the 45 cases developed a spinal deformity such as is seen in juvenile kyphosis. Although the tetanic convulsions were undoubtedly responsible for the fractures, it does not necessarily follow that the subsequent kyphos was related to the preceding fractures. Thirty-two cases of kyphos without vertebral fractures would indicate an absence of any causative relationship and suggest the presence of other factors in the production of the deformity. None of our cases developed a typical kyphosis. Callus formation proceeds as rapidly in the body of a vertebra as in any other bone[15] and prompt repair should be expected. Rapid and complete healing does actually take place. Ferguson[10] believes that there is little or no tendency to progressive wedging following injury of a previously healthy vertebra with or without fracture. Progressive wedging following trauma has been described but it is probable that these are pathological vertebrae, either severely decalcified or actually fractured, the fracture being unrecognized at the time of injury.

In the very occasional instance of marked compression and wedging, treatment directed to the correction of deformities is necessary and the accepted orthopedic principles of hyperextension should be applied.[6] Fortunately most of the fractures show minimal deformity, are entirely symp-

Fig. 3. Same case as Figure 2. (*A*) Pre-shock film demonstrates normal lumbar spine. (*B*) Compression fractures of L-2 and L-4. L-4 is an example of a moderate degree fracture with irregularity of the anterosuperior margin and a clear-cut fracture line involving the upper articulating surface. No appreciable wedge deformity. Narrowing of first and third interspaces suggests partial herniation of nucleus pulposus into respective bodies. (*C*) Eighteen months later. Concavities of upper articulating surfaces clearly apparent. Slight sharpening of upper anterior margin of L-2. (*D*) Thirty-one months after initial fractures. No progressive changes. Disc interspaces remain narrowed. There is less deformity of the anterosuperior margin of L-4. Lordotic curve quite comparable to the pre-shock appearance.


A
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tomless or at most cause a mild backache, and recovery takes place without any treatment. From the psychiatric viewpoint, prolonged immobilization in a plaster jacket is undesirable.

Thirty cases have been followed with serial roentgenograms for a period of two to four years after their initial fractures. These patients, all males, of ages ranging from twenty-three to fifty-three years, were treated with electroshock or insulin or a combination of both. All of them had routine roentgen examinations of the vertebral column before and after shock therapy. In the present series the pre-shock films disclosed no evidence of recent or old fractures. There were varying degrees of osteoarthritis, mild porosis, scoliosis and kyphosis, as well as entirely normal spines. After the fractures occurred some of the patients complained of mild to moderate backache while others were entirely asymptomatic. In the absence of symptoms there was no treatment, while those patients with pain rested in bed for several days. Instances of single body fractures were found and in those D-4 or D-5 was usually involved. Multiple fractures were more common, however, varying from two to a group of eight (Fig. 1). One case had fractures of D-4, D-5 and D-7 and two years later, during a subsequent course of shock therapy, developed a fracture of D-6 with no additional injury to the previously involved bodies. Another developed fractures of the dorsal and lumbar spine, all occurring during the same course of therapy (Fig. 2 and 3). On one occasion a refracture of a single body within a group of healed fractures was noted following a subsequent course of treatment. Most of the fractures were of the mild variety, falling into the group of disc repercussion fractures. In these, the abnormal findings consisted of depression of the central portion of the superior articulating surface of the body with a narrow zone of increased density beneath and appreciable interspace narrowing when the depression was prominent (Fig. 1*C* and *D* and Fig. 2*A*). At times the changes were so slight that without the pre-shock films for comparison, especially the lateral exposures, definite fractures could not be discerned. The moderate fractures were unequivocal and disclosed mild compression with fragmentation and anterior wedging (Fig. 3*B*). No severe fractures were encountered. At no time was any portion of the vertebra other than the body involved. The presence of mild osteoporosis or osteoarthritis did not seem to contribute to the severity of the fracture.

During the period of observation, it was apparent that healing took place rapidly and additional pathological changes did not occur. The zone of increased density disappeared after an interval and at most a slight depression of the superior surface of the body remained. Frequently, even this depression became less conspicuous and the contour of the body approached the normal appearance. Comparison films were also necessary in this group, for without them a diagnosis of previous fracture would be questionable (Fig. 2*B* and *C*). At all times the lateral exposures showed the changes more clearly. When interspace narrowing was well defined, it usually persisted but did not increase. On occasions, the periphery of a deep surface impression became surrounded with compact bone and a Schmorl's node resulted (Fig. 1*F* and *G*). There were no additional deformities in those bodies that were compressed. The degree of wedging either remained the same or eventually showed slight improvement (Fig. 4). Slight marginal fragments united promptly with the bodies. Kyphosis or scoliosis did not occur nor was there any exaggeration of preexisting curvatures. Occasionally the involved margins developed slight sclerosis and resembled the late appearance of the ordinary fracture (Fig. 3*C* and *D*). As yet there have been no typical osteoarthritic spurs. From the clinical standpoint there have been no instances of persistent or unusual backache but evaluation along these lines is difficult, especially in the emotionally disturbed patient.

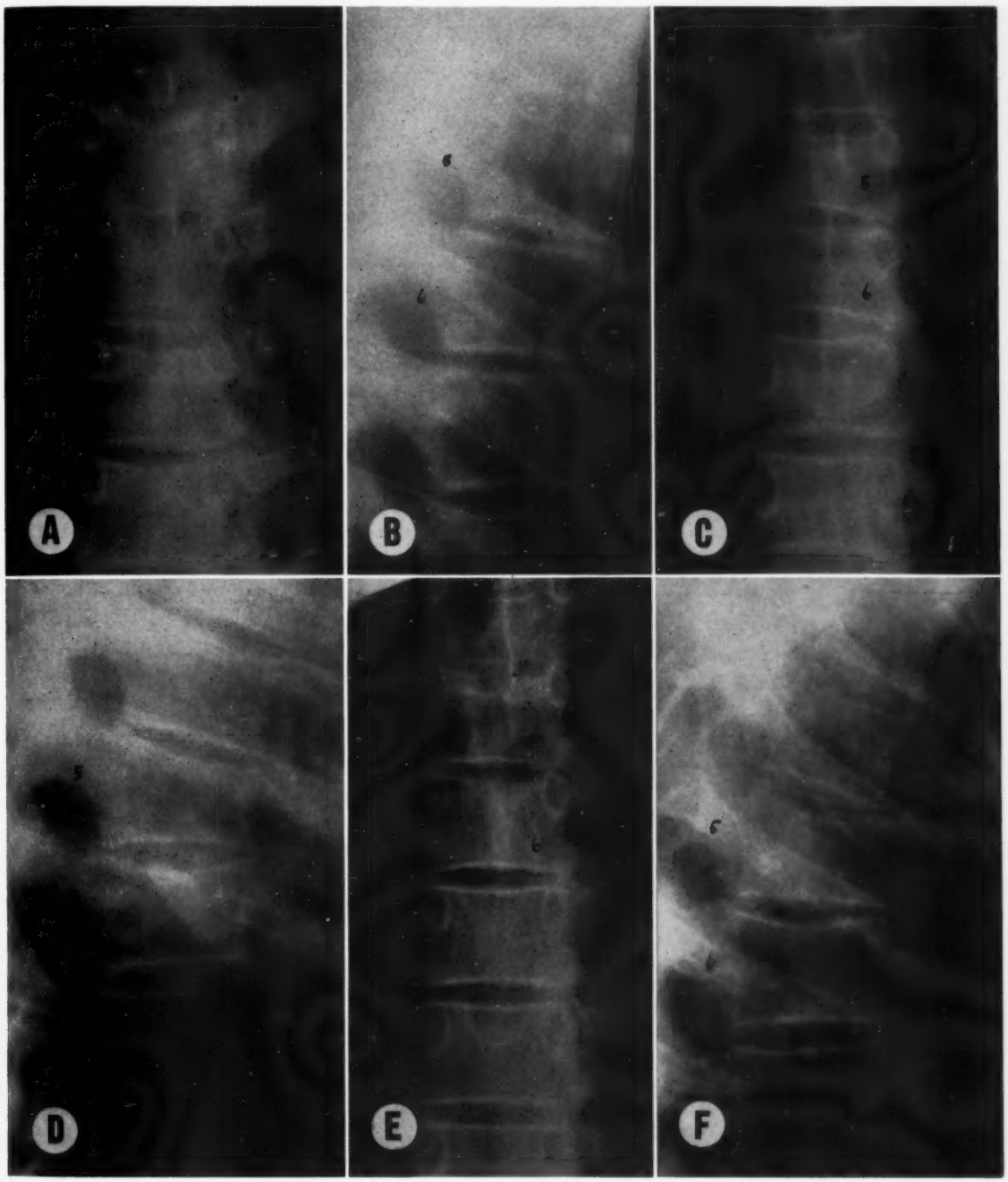

Fig. 4. Male, aged thirty-four. Pre-shock films disclose normal spine. (*A*) Frontal exposure. (*B*) Lateral exposure. (*C*) Thirty months after shock therapy. Frontal exposure discloses healed fractures of *D*-5 and D-6. Residual diminution in height of D-5. (*D*) Lateral exposure reveals wedge deformity of D-5 and slight central concavity of upper articulating surface of D-6. (*E*) Fifty-four months after fractures occurred. Appearance of D-5 and D-6 practically normal on frontal exposure. (*F*) Lateral exposure. Wedging of D-5 less than (*D*) and if viewed without comparison films could be considered normal. D-6 now appears normal.

CONCLUSIONS

1. The complication of vertebral fractures in convulsive shock therapy is not serious and the average fracture does not require specific orthopedic treatment.

2. Intervertebral disc space narrowing appears to be more frequent in the convulsion type fracture than in the ordinary traumatic compression fracture, suggesting that the mechanism of the former is largely disc repercussion while that of the latter is primarily hyperflexion.

3. Observations in a group of thirty cases over a period of two to four years disclose complete healing of the fractures with persistence of any initial disc space narrowing and occasional mild deformities. There were, however, no additional deformities or roentgen evidence of sequential pathological changes.

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THE DIAGNOSIS OF PLACENTA PREVIA WITHOUT THE USE OF CONTRAST MEDIA

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THE determination of presence or absence of placenta previa in patients with vaginal bleeding in the last trimester of pregnancy presents a most important problem in the management of such patients. Several reports on the subject of roentgenologic methods used in diagnosis of placenta have appeared in the recent American literature.[1,2,3,4,6,7] The importance of careful analysis of soft tissue shadows on technically good roentgenograms is stressed by the various authors. In addition, the use of contrast methods, such as injection of air into the bladder or bladder and rectum, or injection of opaque media into the bladder, is frequently resorted to by many writers on this subject. These contrast methods are designed to more clearly demonstrate presence or absence of abnormal soft tissue shadows between the fetal head and the bladder or rectum.

Smith,[6] in his paper, stresses that the diagnosis of placenta previa can be adequately made or excluded with the use of plain films alone, thereby rendering unnecessary the employment of contrast methods. All of the studies on patients reported in this group have been carried out without the use of contrast methods, with uniformly satisfactory results. This report deals primarily with the roentgen findings which have proved most significant in the diagnosis of placenta previa.

Since the opening of Nazareth Hospital in March, 1940, 32 patients have been delivered by cesarean section because of placenta previa. Nineteen of this group were first referred for roentgen examination prior to delivery. In most of these cases there was considerable doubt as to whether placenta previa was actually present or not. In the remainder, which were not referred for roentgen examination, the clinical signs were quite obvious, and further investigation was not deemed necessary. In addition, there was examined a much larger number of patients in whom signs suggestive of possible placenta previa were observed clinically but no roentgen evidence was found to indicate such a possibility. It is in this larger group, where the possibility of placenta previa can be excluded with reasonable certainty, that the roentgen method of examination has proved to be of great value. Likewise, in the instances where the diagnosis of placenta previa is definitely established, the proper surgical procedures can be carried out promptly and the risk of serious sequelae is minimized.

It is hardly necessary to mention that films of good technical quality are essential in this type of examination. Decided improvement in quality of films has been observed since the employment of a rotating anode tube because there is better detail of soft tissues and motion is eliminated due to the shorter exposure time which this tube permits. The technical factors employed are as follows:

1. Anteroposterior supine recumbent position: 36 inch distance, 100 ma. sec., kilovolts (peak) according to thickness.

2. Lateral recumbent position: 36 inch distance, 300 ma. sec., and kilovolts (peak) according to thickness, for bony structures of pelvis and soft tissue at level of inlet.

3. Lateral recumbent position: 36 inch distance, 100 ma. sec., and kilovolts (peak) according to thickness. On this view the uterine fundus is centered so that a good lateral soft tissue view of the entire fundus is obtained.

The maximum exposure time used is one and one-half seconds for the lateral view of the pelvic inlet and the technique is similar to that used in routine pelvimetry.

The other two exposures are made in one-half second. Films are all developed by controlled time-temperature technique, and developing by sight has not been found necessary.

On roentgenograms of satisfactory quality the soft tissue shadows of the uterus and its contents are clearly visualized. The outline of the uterine wall at the level of the pelvic inlet can invariably be identified. In practically all cases, the outline of the bladder is readily visualized unless obscured by abnormal densities. The position of the placental shadow, when it is in the fundus of the uterus, can always be demonstrated except in hydramnios.

Failure to visualize the placental shadow in the fundus of the uterus is a most important finding. This usually occurs in placenta previa of the central type. If most of the placental mass is demonstrated to be below the equator of the uterus, it is definitely significant and highly suggestive of partial or marginal implantation.

Displacement of the fetal head from the mid-coronal or mid-sagittal plane of the pelvic inlet is of importance, especially if seen in conjunction with low position of the placenta.

Abnormally high position of the fetal head in association with an adequate pelvic inlet is a frequent finding, especially in central and partial placenta previa.

Fig. 1 and 2. Case 1. M.B. Fetal head is displaced upward, forward and to the right. Large soft tissue mass seen in pelvis between fetal head and anterior wall of rectum. Rectal wall is indented by mass. Diagnosis: Central placenta previa. Confirmed at operation.

Displacement of the rectum or indentation of the anterior wall of the rectum is an important finding. In instances of central placenta previa there is usually a characteristic dense soft tissue mass demonstrated between the fetal head and rectal wall and the rectum is deeply and smoothly indented by it.

In low anterior placental presentation an increase in width of the extrafetal soft tissue shadow between the fetal head and symphysis pubis is usually seen. Normally this soft tissue thickness is less than 2 cm. If the uterine wall is abnormally thick at this point, the possibility of partial or

marginal placenta previa is likely. The same holds true in cases of low posterior implantation where abnormal soft tissue thickness is demonstrated between the fetal head and the sacral promontory. In many instances, the outer border of the uterine shadow as it extends into the pelvis can be seen at the level of the symphysis and occasionally at the promontory posteriorly. When this border can be identified, any abnormal increase in width between it and the fetal skull is highly significant.

Obliteration of outline of the upper border of the bladder on the anteroposterior soft tissue view, particularly if unilateral, has been found significant in several instances. This occurs when a portion of the placenta obscures detail of the bladder outline and is an important finding. This sign is likely to be missed when full reliance is placed on studies made with the use of contrast media.

Abnormal attitude of the fetus at or near term is significant. In one instance (Case VI) the shadow of the placental mass was clearly demonstrated between the bladder and uterus and is believed responsible for transverse position, as demonstrated in Figures 9 and 10.

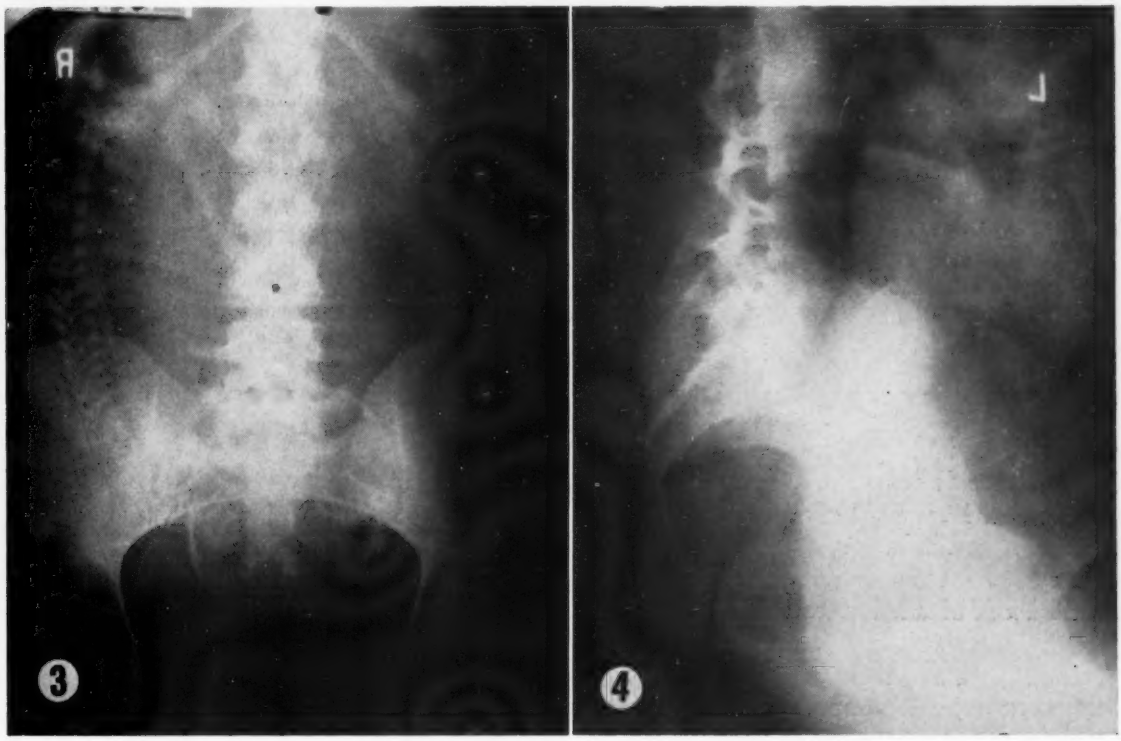

Fig. 3 and 4. Case II. M.S. Fetal head is high, displaced posteriorly and slightly to the left. There is widening of distance between anterior wall of the uterus and fetal head at the level of the symphysis pubis. This is due to abnormal soft tissue mass in the lower uterine segment. Diagnosis: Partial placenta previa. Operation: Marginal placenta previa.

Any combination of the above signs increases the probability of placenta previa and it is usual that more than one sign will be present in a given case.

Central placenta previa usually presents no serious diagnostic problem. Partial placenta previa can also usually be identified without great difficulty. It is in marginal implantations where the most exacting exposure technique and search for diagnostic signs is required.

It is true that presence of cystic or soft tissue pelvic tumors may give signs identical to those described above. Also collections of amniotic fluid in the pelvis may prove confusing. However, in these instances the shadow of the placenta can be demonstrated elsewhere in the uterine cavity. In cases of hydramnois the difficulties are obvious.

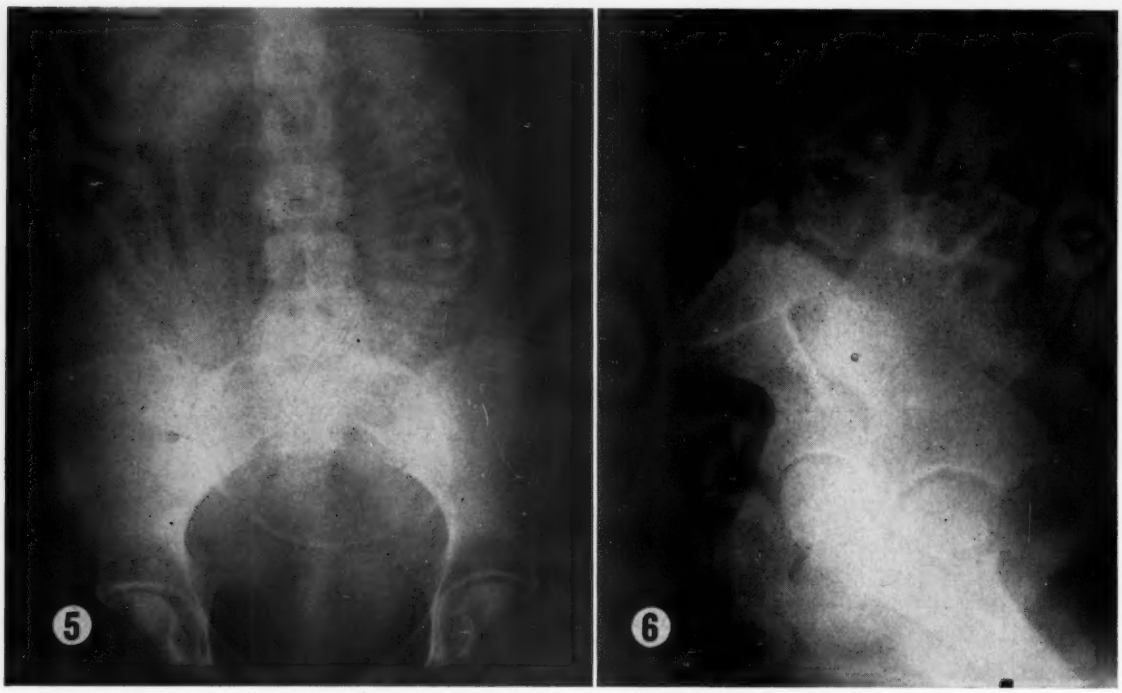

Fig. 5 and 6. Case III. D.C. The placental shadow is low and largely anterior. The fetal head is displaced upward and posteriorly with some flattening of the fetal skull adjacent to the placental shadow. The large soft tissue mass between the upper border of the bladder and fetal skull is readily visualized. Diagnosis: Central placenta previa. Operation disclosed central placenta previa.

The accompanying illustrations (Fig. 1–13) demonstrate the findings noted in 7 of the cases in this series. The diagnostic signs and operative findings in the remainder are as follows:

Case VIII. S. P. Placental shadow low and on left side. Fetal head displaced slightly to the right. Findings are strongly suggestive of marginal placenta previa. At operation marginal placenta previa was found.

Case IX. E. G. Pregnancy of approximately seven lunar months' gestation. Fetal head is high and displaced anteriorly. Large soft tissue mass in pelvis indents rectum and displaces anterior rectal wall posteriorly. Roentgen diagnosis: Central placenta previa. Operation: Partial placenta previa, posteriorly and low.

Case X. R. H. Placental shadow is on the left anterolateral wall of the uterus, chiefly in the lower uterine segment. Head is displaced slightly upward and slightly to the right. Diagnosis: Probably partial placenta previa. Operation: Partial placenta previa.

Case XI. E. G. Placental shadow is anterior and low. The fetal head is abnormally high and displaced to the right and posteriorly. Findings indicate placenta previa, probably central in type. At operation, central placenta previa was found.

Case XII. S. M. There is no significant displacement of fetal head. However, the pelvis is large and there is abnormal widening of soft tissue shadow between fetal head and anterior uterine wall at level of symphysis anteriorly. Greater portion of placental shadow is below

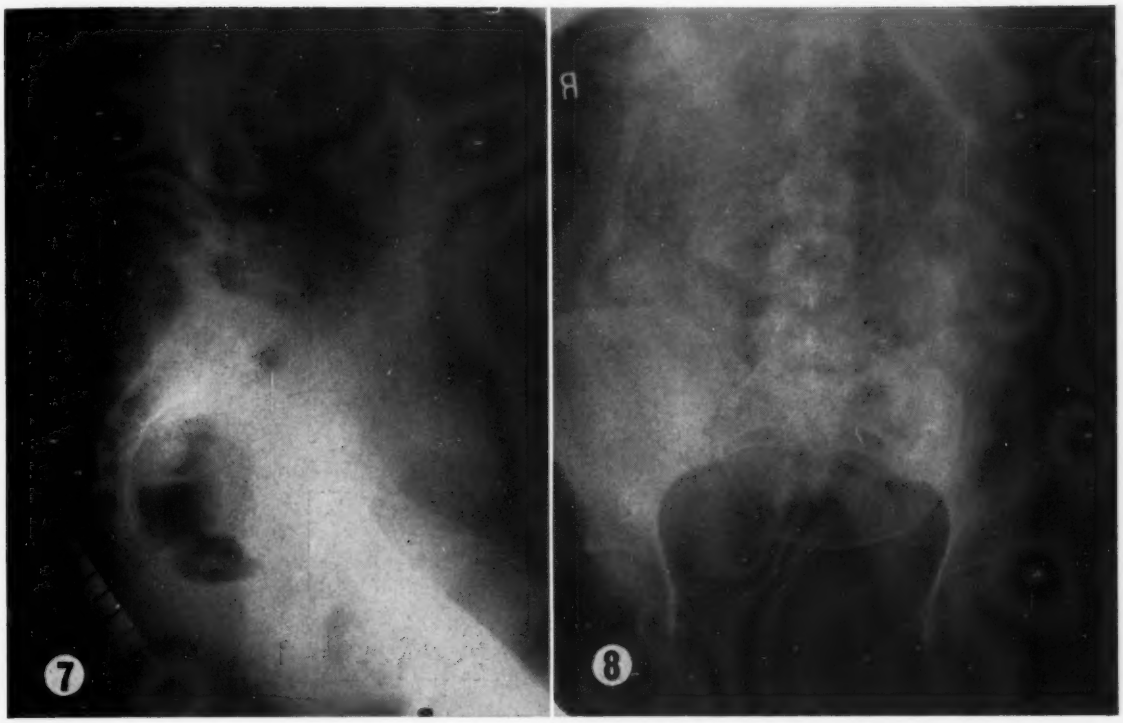

Fig. 7 and 8. Case iv. G.S. Fetal head is displaced upward, forward and slightly to the left. Large soft tissue mass in pelvis is clearly outlined in rectal gas shadow. Diagnosis: Central placenta previa. Operation: Central placenta previa.

equator of uterus. Diagnosis: Marginal placenta previa. Operation: Marginal placenta previa.

Case xiii. A. T. The fetal head is high. The placental shadow is low on the left posterolateral wall of the fundus, largely below the equator of the uterus. Diagnosis: Partial placenta previa. Operation: Partial placenta previa.

Case xiv. G. G. Placental shadow largely below equator, somewhat to left and posteriorly. Abnormal soft tissue shadow between rectum and fetal skull. Fetal head is high and displaced to right. Diagnosis: Marginal placenta previa. Operation: Posterior marginal placenta previa.

Case xv. C.V. Signs of intrauterine fetal death. Head displaced anteriorly. Distance between sacral promontory and fetal head is abnormally wide. Diagnosis: Partial placenta previa. Operation: Posterior partial placenta previa.

Case xvi. E. W. Placental shadow anterior and low. Fetal head displaced posteriorly. Distance between fetal head and anterior uterine wall at level of symphysis is widened. Diagnosis: Marginal placenta previa. Operation: Placenta previa.

Case xvii. H. S. Fetal head is high and displaced anteriorly. Abnormal soft tissue mass between bladder and fetal head. Placental shadow not visualized in fundus. Diagnosis: Central placenta previa. Operation: Central placenta previa.

Case xviii. S. S. Fetal head is displaced upward and to the left. Large soft tissue mass in pelvis displaces anterior rectal wall posteriorly. Diagnosis: Central placenta previa. Operation: Central placenta previa.

Case xix. M. G. Marked forward displacement of fetal head due to large soft tissue mass between promontory and fetal head. Mass extends below level of pelvic inlet. Diagnosis: Partial placenta previa. Operation: Partial placenta previa.

In the series of 19 patients included in

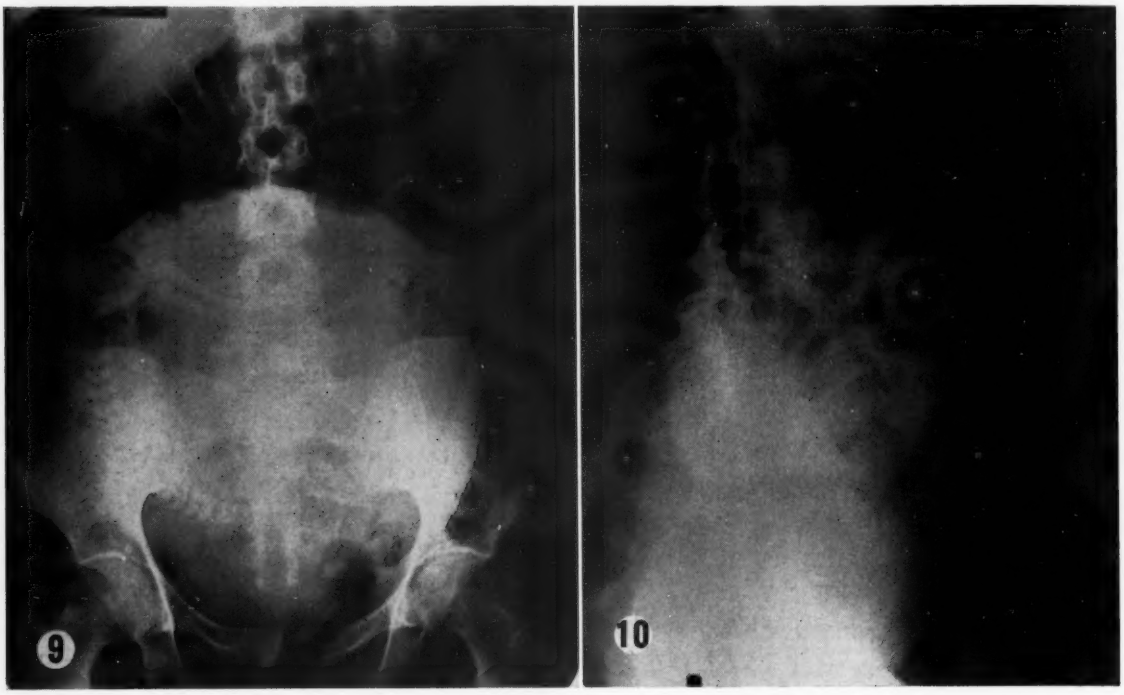

Fig. 9 and 10. Case v. R.H. Transverse position. Large dense soft tissue mass in pelvis lies between bladder and soft tissues of thorax of fetus. These findings persisted on re-examination. Placental mass not visualized in fundus. Diagnosis: Placenta previa, probably central in location. Operation disclosed partial placenta previa.

Fig. 11 and 12. Case vi. M.G. First interpretation based on wet film reading indicated no definite evidence of placenta previa. Review of films on following morning revealed some displacement of fetal head to left. The right border of the bladder is obscured by abnormal soft tissue density in the right pelvis. Signs are indicative of placenta previa of the marginal type. At operation marginal placenta previa was found.

this report a definite or highly probable report of presence of placenta previa was made in all but one instance (Case VI, Fig. 11 and 12). The films of this patient were restudied on the day following examination and sufficient evidence was found to justify diagnosis of marginal placenta previa. This was confirmed at operation which was performed immediately. In instances where the roentgen evidence is in doubt on wet film readings, it is mandatory to carefully re-examine films after they are completely dry.

CONCLUSIONS

The diagnosis of presence or absence of placenta previa can be made with a high degree of accuracy without the use of contrast substances in adjacent pelvic viscera.

Careful study of films is necessary and review of films in doubtful cases is indicated, especially if first reading is made on wet films.

Films of optimum quality are essential, particularly in cases where marginal implantation is suspected.

Important diagnostic signs are as follows:

Failure to demonstrate placental shadow in fundus of uterus.

Low implantation of placenta with major portion below equator of uterus.

Displacement of fetal head from mid-coronal or mid-sagittal plane of pelvic inlet, especially if seen in conjunction with other signs.

Abnormally high position of fetal head.

Abnormal or unusual attitude of fetus.

Indentation of anterior rectal wall or displacement of rectum to either side by abnormal pelvic soft tissue mass.

Increase in width of extrafetal intrauterine soft tissue shadow at level of symphysis pubis anteriorly or sacral promontory posteriorly.

Obliteration of outline of bladder on anteroposterior views, especially if unilateral.

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Fig. 13. Case VII. M.J. Lateral view shows widening of distance between anterior wall of uterus and fetal head at level of symphysis pubis. Fetal head is displaced posteriorly. On anteroposterior (not shown) there is displacement of the head to the left. Diagnosis: Partial placenta previa. Operation: Partial placenta previa.

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PRIMARY MALIGNANT TUMORS OF THE NASOPHARYNX*

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THIS report is based on the findings in 72 consecutive cases of primary malignant tumors of the nasopharynx observed at the Cleveland Clinic in a fifteen year period during the years 1935 through 1949 when 325,000 new patients were seen.

INCIDENCE

Malignant tumors of the nasopharynx are not uncommon, comprising from 1 to 2 per cent of the total number of cancers.[12,20,24]

It is interesting that there is a high incidence of primary nasopharyngeal malignancy in Chinese. During an eight year period at the University of Hong Kong 419 cases of malignant disease were seen, of which 114 were carcinomas of the nasopharynx as compared with only 74 carcinomas of the breast and 174 carcinomas of the cervix.[7]

Malignant neoplasms of the nasopharynx are more common in men than in women. Godtfredsen,[12] in an analysis of 454 cases, found the ratio to be 2 to 1. In our series there were 46 men and 26 women. The youngest patient was a three year old girl and the oldest a seventy-three year old woman. The average age was 46.7 years. This average is considerably lower than for cancer of the adjacent tissues; that is, buccal mucosa, tongue, tonsil and larynx.

PATHOLOGY

Grossly, the tumors of the nasopharynx may be divided into three types: ulcerated, lobular and exophytic.[1] The ulcerated lesions are found, most frequently, high on the posterior wall and usually are differentiated squamous cell carcinomas. Tumors of this type tend to remain localized, and slowly but progressively infiltrate neighboring tissues. In our series there were 7 tumors that fell into this category with eventual involvement of the cranial nerves and the bones of the base of the skull. The lobulated type of tumor usually arises in the region of the eustachian tube and less often in the fossa of Rosenmüller or the pharyngeal tonsil. They are difficult to visualize and rarely are ulcerated. It is not uncommon for them to spread widely beneath the mucous membrane, and the majority are transitional cell carcinomas or lymphoepitheliomas. The exophytic type is smooth and non-ulcerated; they generally arise from the posterior nasopharyngeal wall in the region of the pharyngeal tonsil and are usually sarcomas.

The histopathologic classification of these tumors has presented considerable confusion and disagreement. This difference of opinion centers in part around the term, "lymphoepithelioma" which was first suggested independently by Regaud and Schmincke. Their hypothesis was based on the earlier papers of Retter, Mollier and Jolly, who described the tissue in this region, composed of lymphatic and epithelial elements, as "lymphoepithelium." Some observers[14,22] believe that there is no justification for the term, while others[8] take the opposite view. The entire subject remains in a state of uncertainty at present. To further complicate the classification, Quick and Cutler[26] described a group of epidermoid carcinomas of the nasopharynx which showed orderly types of non-keratinizing cells suggesting duplication of the intermediate layer of stratified epithelium. It was assumed that they arose from the transitional epithelium of gland ducts and therefore were termed "transitional cell epidermoid carcinomas." This premise

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aroused considerable controversy since there was some difficulty in separating the transitional cell and the lymphoepithelioma types. Ewing[9] believed that there was a definite distinction between the two types of tumors and favored both terms. However, New[23] maintains that both the transitional cell carcinoma and the lymphoepithelioma are merely highly malignant undifferentiated epitheliomas and classifies them both as Broders' Grade 4. The great difficulty in the differentation of the lymphoepithelioma, the transitional cell carcinoma, and the anaplastic epitheliomas has been comprehensively expressed by Salinger and Pearlman.[28] They presented a series of cases to Jaffe, Saphir and Cutler for examination and the discrepancies between the opinions of these authorities clearly emphasize the difficulty in differentiation.

The histopathologic classification of the neoplasms in our series follows (Table 1).

Of the 72 cases there were 21 transitional cell carcinomas, 19 squamous cell carcinomas, 9 lymphoepitheliomas, and 4 undifferentiated small cell carcinomas. Two well differentiated carcinomas were found; one was classified as an adenocarcinoma of the cylindroma type and the other was basal cell carcinoma.

Nine were sarcomas; of these 6 were lymphosarcomas; 1 was a reticulum cell sarcoma; 1 was a fibrosarcoma and 1 a lipomyxosarcoma. Pathologic classification was not possible in 8 cases. Biopsy specimens had either been taken elsewhere, with the slides unavailable for re-evaluation, or the unsatisfactory condition of the patient had discouraged the biopsy.

SIGNS, SYMPTOMS AND CLINICAL COURSE

Unfortunately, the signs and symptoms of nasopharyngeal cancer are not recognized early by the medical profession. This situation is undoubtedly an important factor in the high incidence of advanced cases observed.

The symptomatology may be divided into four main categories: auricular, respiratory, neurologic and nodal (Table 1).

The auricular symptoms were the initial complaints of 13 of our 72 patients (18 per cent). Of the 13 cases, 7 had transitional cell carcinomas. These tumors arose in close proximity to the eustachian orifice and the attention of the patient was first attracted by intermittent obstruction of the eustachian tube and varying degrees of tinnitus. Otalgia was observed to a lesser extent early in the disease. As the tumor progressed, the eustachian tube usually became occluded and there was absorption of air and accumulation of secretion in the middle ear. This presented an environment conducive to an infectious

Table 1

CORRELATION OF SYMPTOMATOLOGY AND TUMOR TYPE

Microscopic Classification	Number	Initial Symptom: Auricular	Respiratory	Neurologic	Nodular	Months Duration
Transitional cell carcinoma	21	7	1	5	8	8.7
Squamous cell carcinoma	19	1	9	7	2	12.2
Lymphoepithelioma	9	1	2	0	6	9.5
Unclassified	8	2	2	2	2	7.5
Lymphosarcoma	6	0	1	0	5	8.2
Undifferentiated carcinoma	4	0	3	1	0	10.7
Sarcoma	3	2	1	0	0	4.5
Adenocarcinoma (cylindroma)	1	0	1	0	0	10.0
Basal cell carcinoma	1	0	1	0	0	7.5
Total	72	13	21	15	23	8.7

process. Hoover[16] has emphasized the confusion in diagnosis which may occur when an otitis media arises on this basis. With obstruction of the eustachian tube and otitis media, a conduction deafness results. It is rare for deafness to result from actual involvement of the eighth nerve. Undoubtedly this is because of the protection provided the eighth nerve by the petrous portion of temporal bone.

high, deep cervical region under the upper end of the sternocleidomastoid muscle. The nodes of the lower neck soon become involved and, late in the disease, widespread bilaterally asymmetrical cervical lymphadenopathy is typical. Axillary and mediastinal lymph node involvement is not uncommon from anaplastic lesions. Tumors which developed extensive and early lymph node involvement were usually either transitional cell carcinomas, lymphoepitheliomas, or lymphosarcomas.

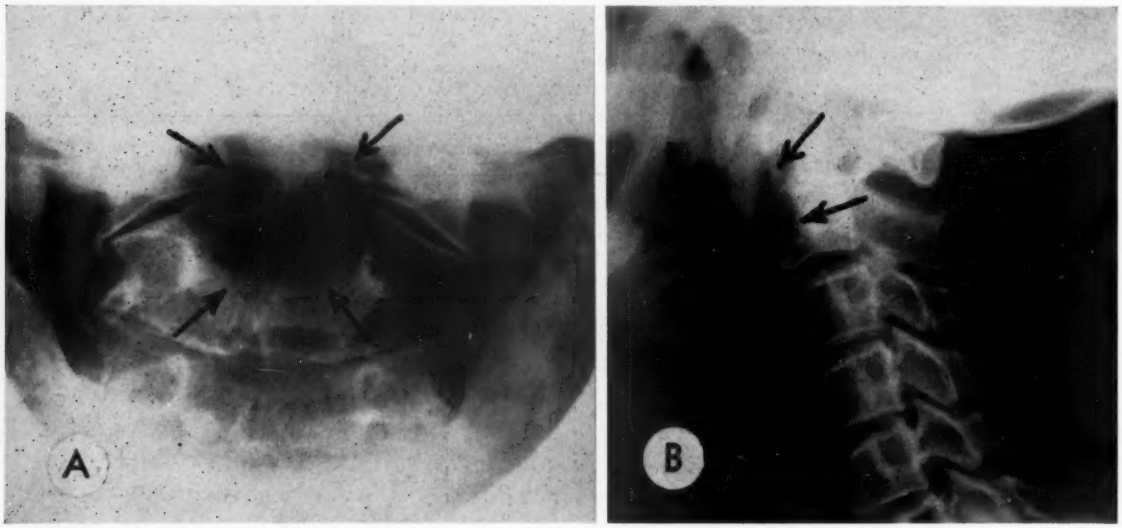

Fig. 1. Anteroposterior (*A*) and lateral (*B*) views of the cervical spine, demonstrating destruction of the first and second vertebral bodies by nasopharyngeal malignancy.

The initial symptoms were in the upper respiratory tract in 21 of our 73 patients (28.7 per cent). Intermittent unilateral nasal obstruction, rhinorrhea, and repeated unexplained hemorrhages were the usual complaints. Obviously, obstructive symptoms do not appear until the tumor has reached significant size and, although profuse rhinorrhea may be an early symptom, the diagnosis of neoplasm is not often considered.

The presence of a painless swelling in one or both sides of the neck was the initial symptom in 23 of our 72 patients (32 per cent). However, when first examined, nodes were palpable in 65.5 per cent. Cappell[5] reports a similar figure and several authors state an even higher incidence.[17,27,28] The nodes most often affected are in the

The neurologic symptoms present one of the most interesting aspects of malignancy of the nasopharynx. The initial symptoms in 15 of our 72 patients were neurologic (23.6 per cent). The frequent involvement of the cranial nerves is due to the close proximity of the nasopharyngeal cavity to the base of the skull and, in particular, to the foramen lacerum and the foramen ovale. These structures offer a minimum of resistance to an invading neoplasm and we found only 1 case in which the tumor penetrated the tough pharyngeal fascia rather than extending superiorly (Fig. 1). After entering the middle cranial fossa, the growth usually remains extradural, producing compression of the cranial

nerves. Because of their anatomic position, the fifth and sixth nerves are most often involved. Unilateral trigeminal pain and paralysis of the lateral rectus muscle of the eye result. Depending on the extent of the tumor, a complete unilateral ophthalmoplegia and amaurosis may occur as the second, third, and fourth nerves become compressed. The seventh and eighth nerves are rarely damaged due to the protection provided by the petrous bone. The cranial nerves from the ninth through the twelfth are all located too far posteriorly to be involved intracranially. However, as they emerge from the jugular foramen high in the retroparotid space, they are in close approximation to the retropharyngeal lymph nodes. Early metastases to these lymph nodes soon implicate one or all of these nerves. Symptoms of difficulty in swallowing, sensory changes in the pharynx, paralysis of the palate and larynx, atrophy of the trapezius and sternocleidomastoid muscles, and hemiatrophy of the tongue result. If the cervical sympathetic trunk is compressed, a narrowing of the palpebral fissure, enophthalmia, and miosis are produced (Horner's syndrome). In our experience, the squamous cell carcinoma was the type of tumor which most often showed neurologic signs and symptoms.

Martin[19] has reported an osteoarthropathy associated with nasopharyngeal malignancy which is similar in type to the typical pulmonary osteoarthropathy. We have seen no cases demonstrating this type of bone pathology.

If untreated, malignant tumors of the nasopharynx eventually progress to a generalized carcinomatosis. In the late stages, pain is frequently a prominent symptom. Death is almost always due to widespread metastasis or intracranial extension. The average length of life from the onset of the first symptom, in the untreated patient in our series, was 17.6 months.

DIAGNOSIS

There is probably no other group of malignant neoplasms in which the correct diagnosis is so frequently overlooked or delayed. Nineteen of our 72 patients had undergone previous operations because of incorrect diagnoses. Teeth extractions, sinus operations, tonsillectomies, adenoidectomies, and other operations of the nose and throat had been performed. In one patient, the middle cranial fossa had been explored because of fifth and sixth cranial nerve involvement. Several patients underwent prolonged ear, nose and throat treatment prior to correct diagnosis. Many authors have reported similar and numerous diagnostic errors.[18,21,23]

The most important procedure in establishing correct diagnosis is careful examination of the nasopharynx. This should be conducted in all cases presenting nasal hemorrhage or obstruction, cervical adenopathy, vague unexplained pain over distribution of the fifth nerve, or auditory symptoms. As Cantril[4] has so aptly stated, because the nasopharynx lies "behind a corner" and requires "patience" and "experience" to adequately examine, it is usually disregarded and/or neglected. No special instruments are required for the examination. An ordinary throat mirror, with the soft palate retracted forward by means of a rubber catheter passed through the nose and out the oral cavity, is sufficient. This procedure actually is more effective than an examination with the endoscope. It should be emphasized that one negative examination is inadequate if the previously mentioned symptoms are present.[10,29] When a questionable area is observed, a large biopsy specimen or several small ones should be taken. Berman and Burman[3] have recommended the use of the LaForce adenotome for this purpose rather than the small straight or curved forceps applied through the nose.

In all patients in whom nasopharyngeal malignancy is suspected, routine lateral roentgenograms and submentovertex stereoscopic views should be made.[2] Examination of the basilar view often shows evidence of bone destruction. Those bones most frequently involved are the body and

greater wing of the sphenoid, and the basiocciput. Later, changes may be visualized in the petrous tips, the posterior portion of the vomer, and the sella turcica (Fig. 2). If the tumor has progressed to significant size, a soft tissue mass may be demonstrated in the lateral views. Changes in the sphenoid and ethmoid sinuses are only evident late in the disease.

Occasionally a case of nasopharyngeal malignancy presents a perplexing diagnostic problem. Godtfredsen[13] reports 2 cases which appeared as primary parotid tumors. One of these was an adenocarcinoma of the cylindroma type and therefore easily confused with a true primary parotid tumor.

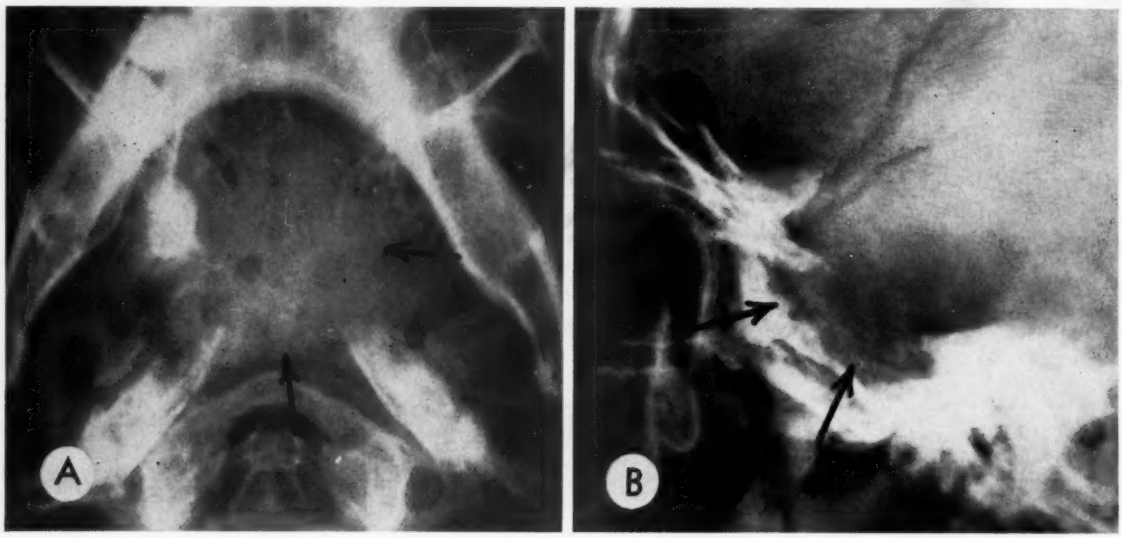

Fig. 2. Submentovertex (*A*) and lateral (*B*) views of the skull, showing extensive destruction of the sphenoid, basiocciput, petrous tips, and the sella turcica from nasopharyngeal malignancy.

TREATMENT

Radiotherapy is accepted almost universally as the only treatment for malignant tumors of the nasopharynx.[1,6,7] No matter how radical the surgical procedure, the location and common anaplastic features of these tumors render complete excision and cure impossible. Nielsen[24] makes the statement that he has never seen a report of a surgical cure; this also has been our experience.

Primary nasopharyngeal malignancy is treated at the Cleveland Clinic by external irradiation in the 200 to 250 kv. range. A target-skin distance of 50 or 80 cm. is employed. One millimeter copper or Thoraeus filter is used, giving a half-value layer of approximately 2 mm. of copper. Radiation is delivered through four portals, two anterior and two lateral. Each anterior field measures approximately 25 to 45 sq. cm. or 6 cm. in diameter over the maxillary sinuses. The beam is angled slightly inward and upward so that the nasopharynx is crossfired. A lead shield protects the eyes. The lateral fields are larger, measuring approximately 70 to 100 sq. cm., depending on the type of neoplasm. Each of these fields includes the external ear, the base of the skull, and the angle of mandible. Perlman,[25] investigating the effects of irradiation of the normal ear, found that a dose of approximately 5,000 r has no harmful effects. We deliver a skin dose of 200 to 250 r daily to each of the right and left portals alternately. The total dose is carried to skin tolerance, usually about 3,500 to 4,000 r to each field. The tumor dose should be at least 4,000 r. Occasionally a second course has been administered after several months. The use of radium has been restricted to the implantation of radon seeds following external roentgen irradia-

tion. We reserve this procedure for well differentiated squamous cell carcinomas and adenocarcinomas when a high local dose of radiation is essential. The use of intraoral roentgen irradiation is of little value as the beam is too small and there is considerable difficulty in angulation.

When cervical lymph node metastases are present or in most cases even though not palpably enlarged, an attempt is made to irradiate lateral fields of the neck. If involvement is extensive, two lateral cervical fields will be necessary. Large fields are used when dealing with anaplastic tumors; the dose of radiation is carried to skin tolerance. Nielsen[24] has emphasized the importance of controlling these metastatic lesions. In 15 autopsied cases in which the patients were treated by irradiation and died of metastases, 9 showed no remaining evidence of the primary lesion.

In far advanced carcinomatosis, palliative therapy is of value in relief of pain.[23] We usually employed a skin dose of 1,500 to 2,500 r to medium sized fields. Pain due to bone metastasis was well controlled. However, when pain occurred due to invasion of the base of the skull, irradiation was of little benefit. Several neurologic surgical procedures were instituted in these cases.

General supportive measures are of great importance if successful irradiation is to be obtained. We have found the use of 100 mg. tablets of dramamine three times a day of considerable value in combating radiation sickness. A high vitamin diet with adequate fluid balance should be maintained. Occasionally, it is advantageous to hospitalize the patient for a period of one to two weeks during the height of reaction in order to decrease the severity and shorten the convalescence period. Also, the use of 5 per cent alcohol as part of intravenous medication is effective. Fox[10] has recommended penicillin as a preventive against secondary infection, particularly where the base of the skull is involved. The local reaction of the skin is treated by the application of a bland ointment. Symptoms of

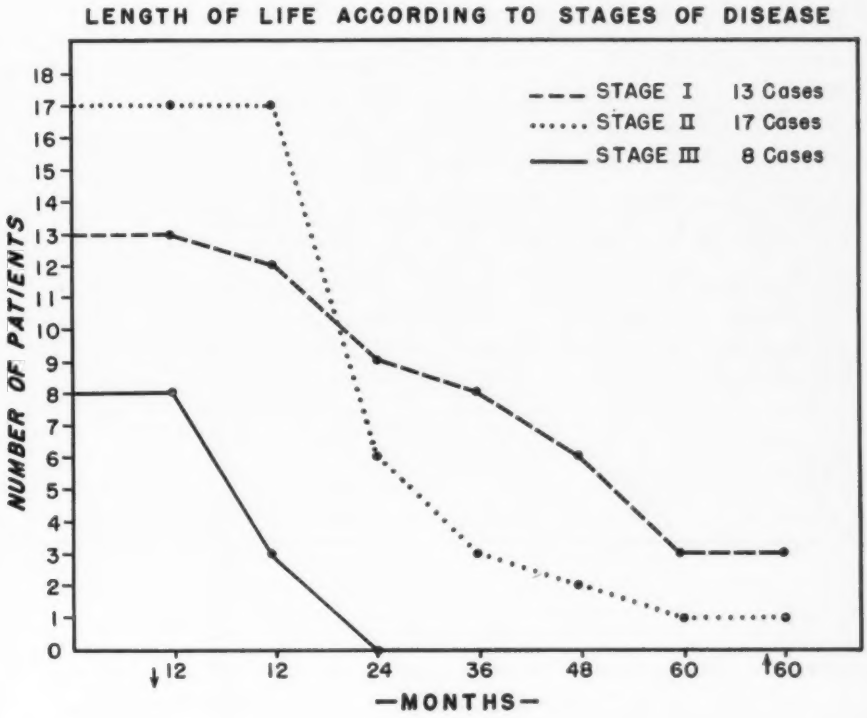

Chart I

Table II

Microscopic Classification	Stage I	Stage II	Stage III	Total
Transitional	2	9	2	13
Squamous cell	3	1	4	8
Lymphosarcoma	1	3	0	4
Lymphoepithelioma	2	1	0	3
Sarcoma	2	1	0	3
Unclassified	0	2	1	3
Undifferentiated carcinoma	1	0	1	2
Adenocarcinoma	1	0	0	1
Basal cell carcinoma	1	0	0	1
Total	13	17	8	38

mucosal changes are minimized by the use of frequent alkaline and saline irrigations.

PROGNOSIS AND RESULTS

The prognosis at present is generally poor but can be improved by earlier diagnosis. Various authors have reported instances of practically no cures[11,15] to 29 per cent five year cures.[18,24] It is difficult to compare accurately these statistics because of the variation in stages of the disease in different series of cases. For this reason we have attempted to establish a clinical grouping on the basis of the local manifestations, palpable lymph nodes and neurologic signs. The following stages are proposed:

Stage 1: Tumor limited to nasopharynx; no palpable lymph nodes and no neurologic signs.

Table III

END RESULTS IN 38 CASES OF NASOPHARYNGEAL MALIGNANCY TREATED BY IRRADIATION

Microscopic Classification	Number Treated		Period of Survival in Months from Treatment: Less than 12	12	24	36	48	60	More than 60
Transitional cell carcinoma	13	dead	10	9	3	3	3	1	1
		living	3	3	0	0	0	0	0
Squamous cell carcinoma	8	dead	6	4	2	2	2	1	1
		living	2	2	0	0	0	0	0
Lymphosarcoma	4	dead	2	2	2	0	0	0	0
		living	2	2	1	1	1	0	0
Lymphoepithelioma	3	dead	1	1	1	1	0	0	0
		living	2	2	2	0	0	0	0
Sarcoma	3	dead	2	1	1	1	0	0	0
		living	1	1	0	0	0	0	0
Unclassified	3	dead	3	2	0	0	0	0	0
		living	0	0	0	0	0	0	0
Undifferentiated carcinoma	2	dead	2	1	1	1	0	0	0
		living	0	0	0	0	0	0	0
Adenocarcinoma	1	dead	1	1	1	1	1	1	1
		living	0	0	0	0	0	0	0
Basal cell carcinoma	1	dead	1	1	1	1	1	1	1
		living	0	0	0	0	0	0	0
Total	38	dead	28	22	12	10	7	4	4
		living	10	10	3	1	1	0	0

(6 additional cases were treated but lost to follow-up.)

Stage II: Palpable cervical nodes; no other evidence of metastases or extension and no neurologic signs.

Stage III: Local invasion of orbit, sinuses, or base of skull; neurologic signs; general carcinomatosis.

Of our 72 patients, 21 were classed in Stage I, 24 in Stage II and 27 in Stage III. Of 13 Stage I cases treated, 8 lived for more than three years and 3 for longer than five years. Of 17 Stage II cases treated, 3 lived longer than three years and 1 for more than five years. Of 8 Stage III cases treated, 3 lived more than one year but none as long as two years. The five year survival rate for the treated cases in Stage I was 23 per cent, Stage II 6 per cent, and Stage III 0 per cent. Patients whom we did not treat were either terminal Stage III or were treated elsewhere following our diagnosis (Tables II and III and Chart 1).

Histopathologically, we found no specific group in which the results of treatment were outstanding. Generally speaking, the anaplastic and well differentiated tumors were the most difficult to control. Those which responded well were sufficiently anaplastic to be radiosensitive, yet showed enough differentiation to be slow in metastasizing.

SUMMARY

A review has been made of malignant tumors of the nasopharynx, based on observations in 72 consecutive cases seen at the Cleveland Clinic from 1935 to 1949 inclusively.

The incidence of these tumors is 1 to 2 per cent of all cancer cases.

Diagnosis is usually made late in the disease.

Roentgen therapy is the treatment of choice because of the inaccessible location and common anaplastic types of neoplasms.

A clinical staging is suggested, based on palpable lymph nodes and neurologic signs.

Prognosis is poor. Even in our Stage I group only 23 per cent five year survivals were obtained. The over-all five year survival rate was 10 per cent. However, life expectancy in the treated patient is more than twice that of the untreated one.

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DISCUSSION

Dr. William E. Howes, Brooklyn, New York. It is indeed a pleasure to discuss this paper. The nasopharyngeal mucous membrane consists of non-keratinizing stratified squamous or columnar epithelium. Numerous lymphoid collections along with mucous glands are also present. The greater proportion of malignant growths to arise here would logically be carcinomas of the epidermoid type. As in the posterior mouth, most of these are the transitional cell type. The adenocarcinomas, including the cylindroma, are rare. Dr. Bolker, pathologist at the Brooklyn Cancer Institute, does not differentiate between the transitional cell carcinoma and the so-called lymphoepithelioma as described by Schmincke and Regaud.

The incidence of lymphosarcomas at the Cancer Institute parallels the experience of the authors at the Cleveland Clinic, approximately 1 to 8 or 1 in 10. I wonder, however, if lymphosarcomas do not appear more frequently. The attending physician becomes so engrossed with treating the obvious cervical masses that he fails to examine the nasopharynx for a possible asymptomatic growth. In this regard, I do not doubt that foci of other lymphoblastomas might be found if a more routine search were made of the nasopharynx.

The authors have emphasized the varied and baffling symptoms due to growth and spread of nasopharyngeal neoplasms. They have also described the difficulties necessary to properly examine the nasopharynx, which accounts for the frequent failure to make the diagnosis at all or until late in the course of the disease. To biopsy an enlarged cervical gland before searching the nasopharynx is a common and, I must say, inexcusable error. The advancing edge of the nasopharyngeal carcinoma is prone to burrow beneath the normal mucosa, making it difficult to bite deeply enough to reach the deeper layer of tumor cells. Thus, a negative biopsy of a suspicious lesion does not rule out cancer and repeat biopsy is indicated.

As you all know, surgery is difficult and mutilating. Radiation therapy is the treatment of choice. I have no criticism of the treatment as outlined at the Cleveland Clinic, namely, to deliver 4,000 r by giving 240 r daily, with factors as stated. The cervical glands are so frequently involved that we at the Cancer Institute use large lateral ports 8 by 10 cm., or even 10 by 15 cm. to crossfire both the nasopharynx and the neck at the same time. With larger portals, it becomes increasingly more difficult to build up an adequate tumor dose without producing severe reactions, such as pharyngitis with difficulty in swallowing, skin injury, and so forth; so at times we augment the tumor dose to the nasopharynx by using two anterior paranasal portals 4 by 4 cm.

Dr. Portmann did not mention in the paper but he did in his discussion that they had ruled out the use of radium. We have augmented our dosage by placing one to four radium tubes either in a catheter or by means of a Blady nasopharyngeal applicator in the nasopharynx. I do feel that in one case this radium resulted in necrosis of the palate and extension of the carcinoma into the mouth, and that our poor result in that case was possibly due to injury secondary to the insertion of radium. I am, however, not entirely sold on the idea that we

should not continue with the radium in the nasopharynx.

It is only by re-emphasis of the baffling symptoms and by insistence on adequate and early examination of the nasopharynx that these tumors can be recognized in the so-called Stage I when, with adequate irradiation, a more hopeful prognosis exists. Dr. Portmann and Dr. Geist are to be congratulated on this re-emphasis.

Dr. Charles L. Martin, Dallas, Texas. I think you will all agree that I have exerted considerable will power in not discussing low intensity radium needles during this meeting. Dr. Portmann's paper offers an opportunity which I cannot resist.

For the most part, his method of using roentgen treatment for nasopharyngeal tumors meets with my full approval. However, radium can be used to great advantage in the care of the two lesions under discussion.

One is the so-called mixed tumor, found in the pharynx, palate and cheeks, which in my opinion is usually an adenocarcinoma, probably of salivary gland origin. Contrary to the statements made in most textbooks, this tumor responds very well to interstitial radium irradiation, preferably low intensity needles. We have recently eradicated such a neoplasm, which filled the entire nasopharynx, with long needles inserted vertically through the soft palate.

Low grade squamous cell carcinoma arising high in the pharynx is also very resistant to roentgen therapy alone. It is often difficult to use interstitial sources in this region but one of the contact applicators which can be fitted into the upper pharynx is a very useful addition to routine roentgen treatment.

It is my impression that Dr. Portmann did not mention chordomas in his paper. Most such lesions are benign and show no response to irradiation but we have had occasion to treat a malignant chordoma presenting in the lateral pharynx which responded very well to roentgen therapy.

Finally, I would like to disagree with Dr. Portmann's statement that all Stage III cases are incurable. We have cured 2 patients both of whom came to our clinic because of strabismus produced by intracranial extensions from transitional cell carcinoma of the pharynx. In each case a large defect was demonstrated in the lacerated foramen by roentgen examination and several cranial nerves were involved. Both patients were women. One has remained well for ten years and one for fourteen years. These cases have provided me with quite a reputation for straightening crossed eyes with roentgen rays.

Dr. Ralph M. Caulk, Washington, D. C. I think there is one histopathologic category in this group that ought to be a little better clarified. Several years ago Dr. Winship became associate pathologist at Garfield Hospital in Washington, having been trained at Memorial Hospital in New York. He introduced the relatively new term to me, of anaplastic carcinoma, for many of the nasopharyngeal tumors. As a consequence, I asked him to review the slides on a large number of our cases of nasopharyngeal cancer. A number of the cases that had previously been called transitional cell carcinoma, and several reported as epidermoid carcinoma, he preferred to denote as anaplastic carcinomas because of their undifferentiation and high degree of malignancy. It would seem that many pathologists prefer this term; that is, anaplastic, to partially supplant the terminology used by Dr. Portmann in his paper.

Dr. Portmann (closing). I thank the discussants very much. The particular point that we tried to raise was the possibility of staging these malignant tumors of the nasopharynx.

Dr. Howes, we try to irradiate the cervical lymph nodes in almost every case. I have no quarrel with Dr. Martin about the use of radium when lymph nodes are involved. However, I think he is unique in his ability to use low intensity needles. We do not have his skill. I think there are very few who do. However, he cited cases which I understand had to do with patients with involvement of the bone from Stage III neoplasms. Is that correct?

Dr. Martin: These patients had extension through the lacerum foramen with involvement of three cranial nerves.

Dr. Portmann: Of course, we don't know whether there was bone involvement.

Dr. Martin: Yes, it was definitely demonstrable in the films, if that is what you mean.

Dr. Portmann: All right. I know we have had great difficulty in curing patients with bone involvement from malignant disease.

Dr. Caulk's comment about the histopathology of these tumors is interesting because I think it is Dr. New who classified these cases as carcinomas, Broders, Grade 4.

RADIUM TREATMENT OF CANCER OF THE UTERINE CERVIX BY THE MANCHESTER SYSTEM

USE OF PLASTIC VAGINAL APPLICATORS

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THIS paper presents a modification of the vaginal units used in the Manchester system for treating cancer of the cervix. It is not intended as a discussion of the relative merits and physics of treating cancer of the cervix by the Manchester system. For such discussion the reader is referred to the current literature.[1,2,3,4]

The vaginal units commonly used in the Manchester system are made of hard rubber (Fig. 1). The use of these hard rubber units presents the following technical disadvantages:

1. They are difficult to grasp or hold when inserting or removing.
2. The radium is not secured tightly in the units.
3. The units are ovoid and have a tendency to rotate.

The authors have devised vaginal units made of plastic and have added certain improvements. The size and therefore the physics of the Manchester system has been maintained.

The technical advantages of these plastic units are:

1. Holes for inserters have been drilled and threaded. The inserters are 12 inches long which aids in radiation protection (Fig. 2).
2. Holes have been drilled at the top through which linen thread has been passed to secure the radium tightly and to facilitate in its removal (Fig. 2).
3. The units can be interlocked after insertion to prevent slippage. This is accomplished by a horizontal groove on the ovoid and a corresponding horizontal shoulder on the spacer and washer (Fig. 3).

CONCLUSION

A plastic modification of the vaginal units used in the Manchester system of radium treatment of cancer of the uterine cervix is described.[5]

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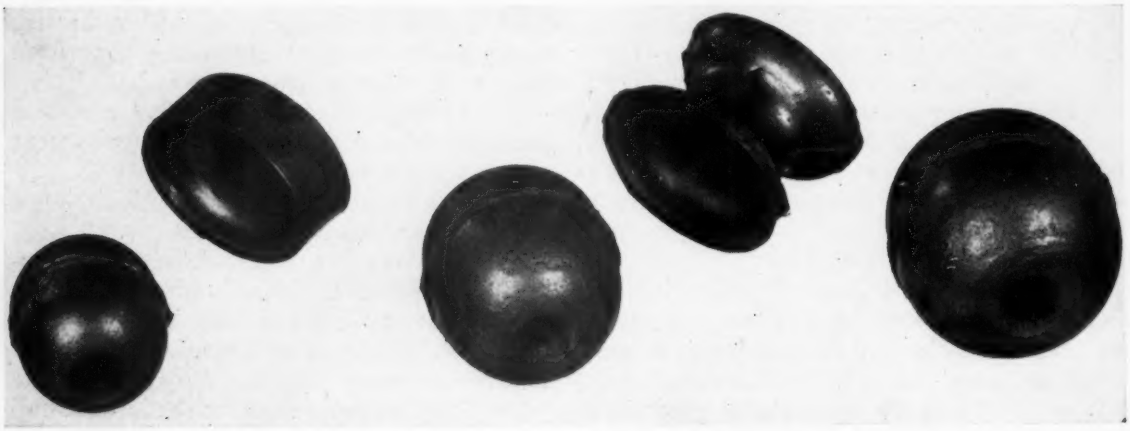

FIG. 1. Conventional Manchester rubber vaginal units. In the foreground are three rubber ovoids in the available sizes. In the background are a washer and spacer, from left to right.

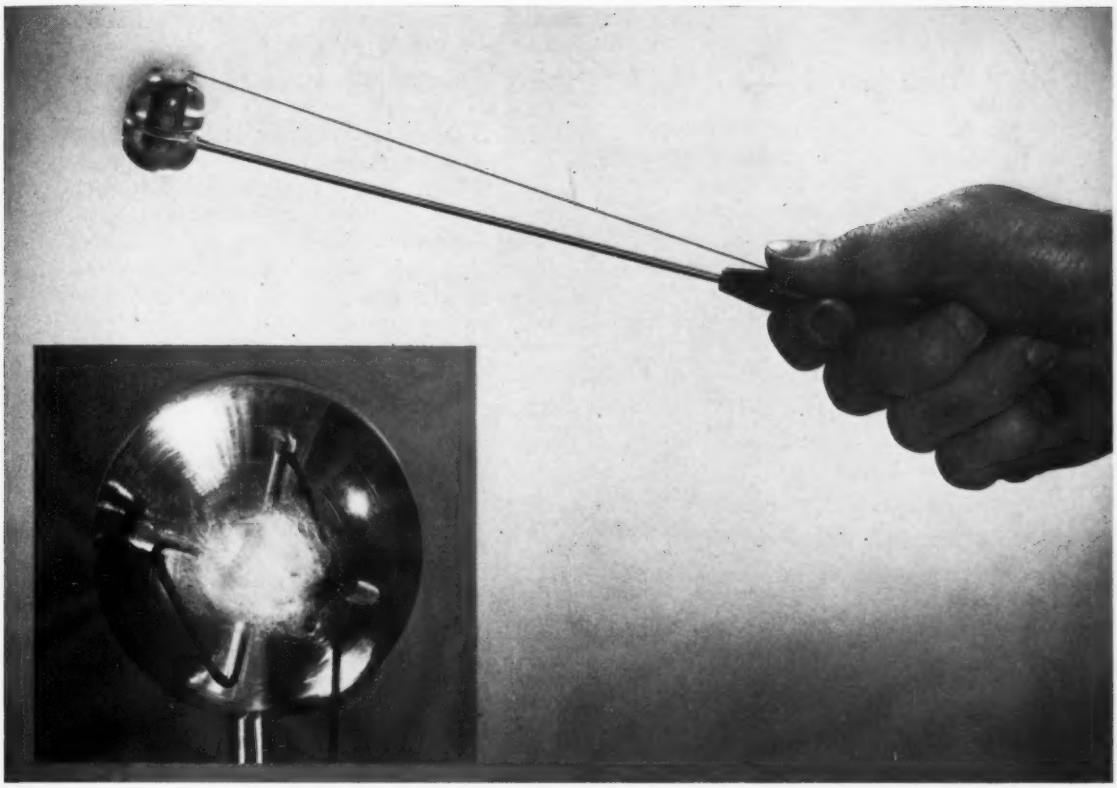

FIG. 2. Plastic ovoid with 12 inch inserter is shown. At lower left is a close-up view of top of plastic ovoid demonstrating the drilled holes and linen thread.

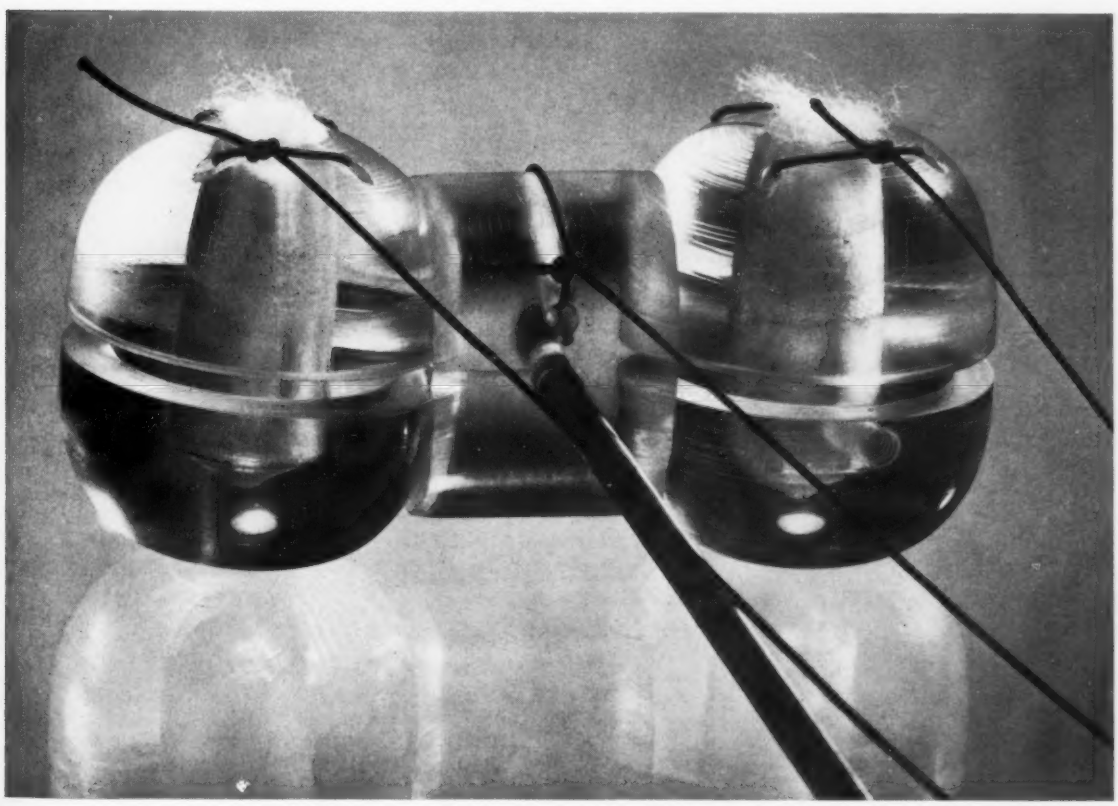

FIG. 3. The completed interlocked unit.

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A CLINICAL STUDY OF RADIATION SICKNESS

EVALUATION OF ETIOLOGICAL FACTORS INFLUENCING INCIDENCE AND SEVERITY*

By FRIEDRICH ELLINGER, M.D.,† BERNARD ROSWIT, M.D.,‡ *and* JOSEPH SORRENTINO, M.D.§

INTRODUCTION

DESPITE recent advances in radiological research, radiation sickness continues to be an obstacle to the successful administration of clinical radiation therapy for benign and malignant disorders. In a previous publication,[1] a method was presented for critical evaluation and recording of the clinical symptoms of this complication.

In this paper we shall present a more detailed analysis of some of the important factors which may influence the incidence and severity of radiation sickness. Among these factors are included the patient's age, body section irradiated, type of irradiated tissue, disease process treated, daily dose of radiation, surface area irradiated, and treatment period.

CLINICAL MATERIAL

A group of 254 patients, all males but 6, form the clinical material for this study during an observation period of seventeen months. These individuals were receiving deep roentgen therapy in our Radiation Clinic for a variety of disease entities, principally maligannt in character.

Deep roentgen therapy was employed, of a quality ranging from a half-value layer of 1 mm. Cu to 4.3 mm. Cu, with a target-skin distance of 50 to 70 cm., and portals ranging from 50 sq. cm. to 400 sq. cm. Treatments were given daily except Sundays and holidays at levels ranging from 50 r in air to a single portal, to 150 r in air to each of three portals.

METHOD

The symptoms of radiation sickness, when they occurred, were carefully recorded daily from the onset of the course of irradiation to the date of its termination. A special chart previously described (see Table 1) was utilized for the precise recording and grading of the severity of the symptoms and signs from day to day. These were grouped in the following manner, according to their severity:

Group I. *No radiation sickness.* This group includes patients who never exhibited general symptoms (headache, dizziness and weakness) or gastrointestinal symptoms (loss of appetite, nausea, vomiting, and diarrhea).

Group II. *Moderate radiation sickness.* This group includes patients exhibiting only general symptoms.

Group III. *Severe radiation sickness.* This group includes patients exhibiting nausea and/or vomiting in addition to the general symptoms described above.

For the evaluation of the roles played by the amount of radiation (measured in air) and the area of irradiated tissues (measured on the surface), in producing the symptomatology of radiation sickness, the following procedure was devised: The total number of roentgens (in air) received by each portal prior to the appearance of radiation sickness was determined and multiplied by the sum of the areas of all portals exposed during this period. The product of this value was then divided by the total number of days of the entire treatment period prior

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TABLE I

RADIATION SICKNESS CHART

Name Age

Weight

Diagnosis Height

Date																
Radiotherapy																
I. General Symptoms a. Headaches																
b. Dizziness																
c. Weakness																
II. Gastrointestinal a. Lost appetite																
b. Nausea																
c. Vomiting																
d. Diarrhea																
III. Blood a. Hemoglobin																
b. Leukopenia																
c. Thrombopenia																
d. Sedimentation																
IV. Cardiovascular a. Blood pressure																
b. Arrhythmia																
c. Pulse																
V. Psychic Symptoms a. Insomnia																
b. Fear																

Medication

General Condition at Start of Treatment

Sections Treated

Grades O..No Symptoms ?..Questionable x..Positive xx..Pronounced xxx..Very pronounced

to the appearance of radiation sickness. This included Sundays and holidays when no treatment was given. To simplify this expression, this numerical value was diided by 1,000. The final figure was then called the "daily surface intensity factor—DSIF." For example, a patient with Hodgkin's disease was irradiated over the mediastinum and the following factors were employed before he developed radiation sickness: 75 r in air was given daily to one of two alternating portals, each 12 by 12 cm. for a total of 450 r in air to each portal in 14 treatment days. Thus:

$$\frac{450 \text{ r (in air)} \times 288 \text{ sq. cm. (surface area)}}{14 \text{ treatment days} \times 1000} = 9.8 \text{ (DSIF)}$$

RESULTS

Of the entire group of 254 subjects, 163, or 63.6 per cent, exhibited the clinical syndrome of radiation sickness. Of the latter, a total of 69, or 27 per cent, of the entire group developed more or less severe nausea and/or vomiting.

1. *Age Factor.* Table II reveals the age distribution of our series of patients and the symptoms of radiation sickness observed for each age group. No influence of the age upon the incidence or severity of radiation sickness was ascertained. The slightly lesser incidence above fifty years of age is statistically not significant.

2. *Body Section Factor.* In Table III will be found a record of the incidence of radia-

Table II

AGE DISTRIBUTION

Age Group Years	Radiation Sickness			No. Cases	Incidence	Severity
	None	Moderate	Severe		Per cent sick all cases	Per cent severely sick
11–20	6	1	2	9	33%	—
21–30	25	31	18	74	66%	24%
31–40	11	14	21	46	76%	45%
41–50	15	14	11	40	62%	27%
51–60	27	22	11	60	55%	18%
61–70	6	5	3	14	57%	21%
71–80	2	1	1	4	50%	—
Uncertain	—	5	2	7	—	—
Total	92	93	69	254	63.6%	27%

Table III

INFLUENCE OF BODY SECTION IRRADIATED

Body Section	Radiation Sickness			No. Cases	Incidence	Severity
	None	Moderate	Severe		Per cent sick all cases	Per cent severely sick
Head and Neck	36	21	17	74	51%	22%
Thorax	16	20	17	53	70%	32%
Abdomen	13	16	14	43	70%	32%
Trunk	7	28	13	48	85%	27%
Pelvis	10	7	7	24	58%	29%
Others	10	1	1	12	16%	16%
Total	92	93	69	254	63.6%	27%

Table IV

INFLUENCE OF "DAILY SURFACE INTENSITY FACTOR—DSIF" ON SEVERITY OF RADIATION SICKNESS

Body Section Treated	Radiation Sickness								
	None			Moderate			Severe		
	DSIF			DSIF			DSIF		
	Arith. Mean	No. Cases	Stand. Dev.	Arith. Mean	No. Cases	Stand. Dev.	Arith. Mean	No. Cases	Stand. Dev.
Head and Neck	17.7	36	2.61	19.8	21	1.65	21.7	17	—
Thorax	38.2	16	4.16	38.0	19	—	36.0	17	—
Abdomen	16.0	13	2.83	27.0	16	4.23	40.0	14	6.64
Trunk	—	7	—	40.0	28	4.67	55.0	13	4.75
Pelvis	36.5	10	5.95	—	7	—	—	7	—

tion sickness according to the body section irradiated. There may be noted a statistically significant lesser incidence among patients treated in the region of the head and neck compared with those treated over the thorax, abdomen and trunk. The lower incidence in patients treated over the pelvis as compared with those treated over the thorax and abdomen approaches statistical significance using the X^2 test. However, the slightly higher incidence observed in patients treated over the entire trunk as compared with those irradiated over the abdomen or the chest alone is statistically not significant.

3. *Daily Surface Intensity Factor—DSIF.* In Table IV may be noted an analysis of the influence of the average or mean of the Daily Surface Intensity Factor (DSIF) upon the incidence and severity of radiation sickness in each of the body sections treated. In any single body section studied, except in the thorax, the severity of symptoms appears to be directly proportional to the value of the average or mean of the daily surface intensity factor. For example, in the abdominal section, a mean DSIF of 16 produces no radiation sickness while a DSIF of 27 produces moderately severe radiation sickness and a DSIF of 40 made the patients severely ill with nausea and/or vomiting. These data are of definite statistical significance.

4. *The Disease Factor.* An analysis of the influence of the disease entity in the patient under treatment upon the incidence of

Table V

INFLUENCE OF DISEASE ENTITY

Disease	Radiation Sickness			No. Cases	Per cent sick all cases	Per cent severely sick	DSIF
	None	Moderate	Severe				
Section A—Abdominal Irradiation							
Leukemia	8	1	5	14	43%	36%	7
All others	5	15	9	29	82%	31%	41
Section B—Trunk Irradiation							
Arthritis	3	17	6	26	92%	24%	37
All others	5	11	6	22	77%	28%	55

radiation sickness is presented in Table v. In Section A of this table the incidence of radiation sickness in leukemic patients receiving irradiation over the abdomen is compared with the incidence in all other patients treated over the same area. The percentage incidence is then compared with the average DSIF. It is of interest that in spite of the exceedingly smaller value for the DSIF in the leukemic group, the percentage incidence of severe radiation sickness is about the same as in all other cases wherein the value of the DSIF is about six times greater. If one consideres the severely ill cases only, the DSIF of the leukemics is significantly less than that for all others in this group ($P=0.01$). This suggests an increased susceptibility of the leukemic patients for the development of the symptoms of radiation sickness.

In Section B of Table v, the incidence of radiation sickness in patients irradiated over the trunk for arthritis is compared with that in all other cases. Here one notes the increase in the total percentage of radiation sickness in the arthritic group despite the employment of a smaller DSIF. If one considers the DSIF of moderately ill patients only one finds a statistically less significant difference with the rest of the patients ($P=0.02$).

DISCUSSION

It is of interest to discuss first the finding that patients treated over the thorax differ in their systemic radiation reactions from those patients treated elsewhere in the body. There seems to be no direct correlation between the DSIF and the severity of radiation sickness in individuals receiving thoracic irradiation (see Table iv). All were receiving radiotherapy for tumors in the lung fields or mediastinum. It may be suggested that differences in degree of replacement of normal lung tissue by neoplasm may explain the different systemic reactions to radiation of individuals receiving the same DSIF. Thus, the more tumor present, the more likely and the more severe the radiation syndrome to be encountered. This suggestion is based on the measurements of Stutz[3] who observed that the lungs of patients with pulmonary tumors showed depth dose values similar to those found in measurements made in water or in muscle tissue. In normal lung tissue, however, smaller values were recorded, owing to a relative decrease in absorption of radiation.

In the present study, a detailed consideration of the volume of irradiated tissue has not been undertaken. Nevertheless, it is possible to compare the influence of variations of the DSIF upon the severity of radiation sickness in each body section irradiated, with data at our disposal. These data have been established with satisfactory accuracy and still permit transformation into volume doses if so desired. Thus, comparison of our results with those obtained by other investigators appears possible.

The observation that patients with rheumatoid arthritis have an increased susceptibility to the development of radiation sickness appears understandable in view of Selye's[2] classification of rheumatoid arthritis as a disease of adaptation.

SUMMARY AND CONCLUSIONS

1. We have presented a consideration of several important factors which appear to influence the incidence and severity of radiation sickness encountered in the clinical practice of therapeutic radiology.

2. In a total of 254 individuals receiving deep roentgen therapy for a variety of benign and malignant disorders, 163, or 63.6 per cent, developed the clinical syndrome of radiation sickness. A total of 69, or 27 per cent, were found to have experienced nausea and/or vomiting of varying degrees of severity.

3. The patients' age did not appear to have any influence on the incidence or severity of this complication in this group of adult individuals.

4. Radiation sickness was more common and more severe in those patients irradiated over the thorax, trunk and abdomen, in

contrast to those who received radiation in other body sections such as the head and neck, pelvis and elsewhere.

5. The radiation dose, the surface area and the treatment period appeared to have a significant influence upon the incidence and severity of the radiation syndrome. These factors were integrated in the form of a value described as the daily surface intensity factor, or DSIF. The severity of the symptoms appears to be directly proportional to the average or mean DSIF, except in the case of the thorax.

6. It appeared that patients suffering from leukemia as well as those with rheumatoid arthritis showed an increased disposition for the development of radiation sickness.

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THE PROBLEM OF ROENTGEN STIMULATION*

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THE phenomenon of roentgen stimulation is one of the most important and, at the same time, most obscure and least investigated problems of modern roentgenology. According to the Arndt-Schulz law, weak irradiations accelerate vital processes, moderate ones promote them, strong doses inhibit them, and the strongest destroy them (Gordon[19]). But according to the observations of many authors, this principle should not be called a "law", since it cannot be applied in all cases (Holzknecht,[27] Czepa,[10] Warren,[60] and others).

Some authors feel that roentgen stimulation does not occur, and that where stimulating effects of roentgen rays are described, these effects are the results of poorly organized experiments. For example, Schwarz, Czepa and Schindler[52,53] have pointed that when small numbers of experimental animals or plants are used, their wide range of variation may give the impression that stimilation has occurred in some of them (see also Warren[60]). It is possible that, in many cases, the latter statement is true but, on the other hand, there are numerous observations on the stimulating effects of roentgen rays, which will be described in this paper, that make it necessary to admit the existence of a very strange and paradoxical phenomenon in which roentgen rays produce two diametrically opposed effects, *i.e.*, inhibition and stimulation (Holzknecht[27]).

According to the observations of Kienböck,[34] Stephan,[57] Gordon,[19] and others, roentgen rays can, in some cases, produce a stimulation of cell function in various organs (kidney, pancreas, thyroid, and others). Luther[38] states that very small doses (10–15 r) may raise the resistance of the organism to the development of tumors. Some authors have observed that roentgen rays have a stimulating effect resulting in the restoration of normal function in cases of amenorrhea and sterility (Rubin,[46] Rock, Bartlett, Gauld and Rutherford,[45] Kaplan[33]). Small doses of roentgen irradiation stimulated the development of the uterus (Geller[17]) and the embryos in rabbits (Driessen[13]). Roentgen rays can stimulate cell divisions in the eggs of *Ascaris megalocephala* and accelerate the healing of wounds (Lazarus-Barlow and Beckton,[35] Schwarz[51]). According to Hastings, Beckton and Wedd,[23] roentgen rays stimulate the development of silkworms. Some authors have observed that roentgen rays stimulate bone marrow function (Bucky and Guggenheimer[7]), lymphoid tissue and increase the number of lymphocytes in the blood (Nakahara,[41] Thomas, Taylor and Witherbee[59]). A stimulation of the development of connective tissue during regeneration in the axolotl has been reported by Litschko.[37] Many authors have described stimulation of plant development following treatment with small doses of roentgen rays (Falta and Schwarz,[15] Pfeiffer and Simmermacher,[43] Johnson,[30] Shull and Mitchell,[54] Sankewitch and Brunst,[47] and others). A number of authors have shown that roentgen rays have a stimulating effect upon the development of amphibians (Gilman and Baetjer,[18] Haecker and Lebedinsky,[21] Hoffmann,[26] Ancel and Vintemberger,[2] and others).

The highly significant observation that malignant tumors may develop following irradiation by roentgen rays or radium has been made by many authors (Hesse,[25] Alius,[1] Dohan and Kienböck,[12] Montgomery, and Viecelli,[39] Saunders and Montgomery,[48] Müller,[40] Hellner,[24] Deuticke,[11] Pohl,[44] Scheffey,[49] Crossen and Crossen,[9] Furth and Boon,[16] Li, Gardner and Kaplan,[36]

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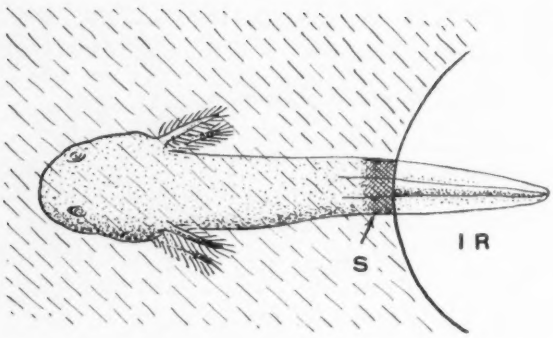
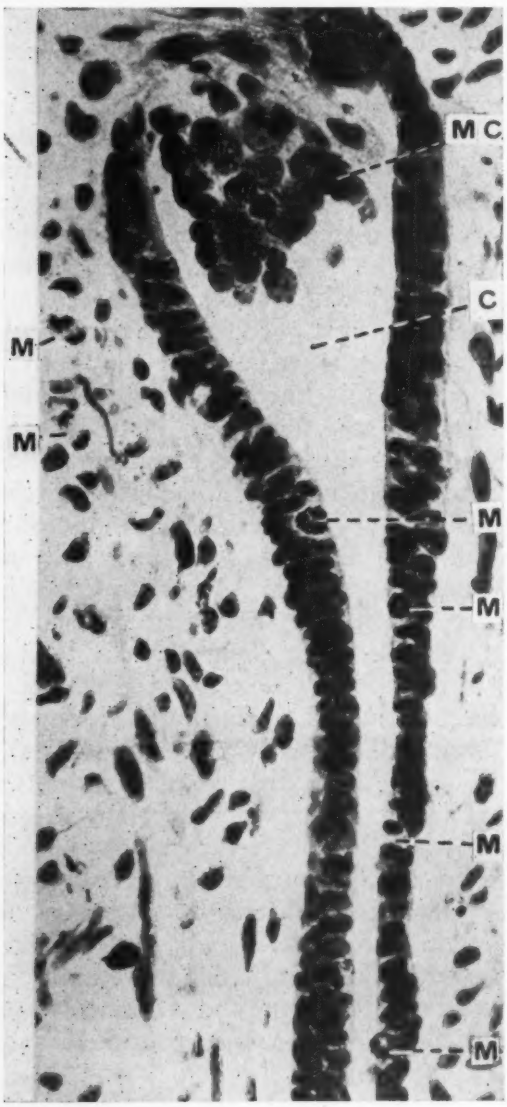


FIG. 1. Diagram illustrating the placement of the experimental animal during local roentgen irradiation of the tail. *IR*, irradiated field; *S*, approximate location of the zone of stimulation.



Kaplan,[31,32] Smith and Bowden,[55] and others). Many of the early roentgenologists died from roentgen cancer. For example, the famous French roentgenologist Bergonié died of roentgen cancer in 1924. According to Hueper[28] the total number of reported cases of occupational roentgen and radium cancers of the skin from all countries is approximately 125. In these cases of occupational cancer, it is clear that the total (cumulative) dose of roentgen rays is not small, is indeed very large. Therefore, it is demonstrated that large roentgen dosages, which result from consistent exposure for many years, have not only inhibiting effects, but may, in some cases, have definite stimulating effects. Halberstaedter and Simons[22] have shown that in certain instances roentgen irradiation may have a primary stimulating influence, followed later by an inhibitory effect.

In the course of previous investigations of the biological effects of roentgen rays, I have had several opportunities to observe the stimulating effects of roentgen rays on development and regeneration in Amphibia.

After local treatment of the tails of young axolotls (*Siredon mexicanum*) a stimulating effect was observed simultaneously with an inhibitory effect (Brunst[4]). Doses of radiation of 1,000 to 6,000 roentgens inhibited tail development in the treated region, but in the narrow peripheral (boundary) zone of the irradiated field, a stimulating effect was observed (Fig. 1). Obviously, in these cases, the peripheral portion had received only a weak dose due to scattering of peripheral rays. In this zone it is typical to find a concentration of small cells in the loose connective tissue, and a large number of dividing cells in all

FIG. 2. Sagittal section through the distal portion of the tail of an animal which was fixed thirty-six days after irradiation with 3,000 r. *C*, cavity of expanded neural tube; *MC*, migration of cells into the cavity of neural tube; *M*, mitotic figures. Photomicrograph. ×400 (From V. V. Brunst, 1950.)

tissues. Mitotic divisions were especially numerous in the neural tube. In many cases a portion of the neural tube lying in the boundary zone expanded to form a neural bulb (Fig. 2). Mitotic figures are seen in some parts of the neural tube in three or four neighboring cells. In a control animal, the end of the neural tube was never expanded, and the number of mitotic figures in cells of the neural tube was small. The intensive multiplication of cells permitted this region to be called the "zone of stimulation". As stated elsewhere (Brunst[4]) the above mentioned zone is one of the signs of the primary acute reaction to irradiation. This reaction never began earlier than the twentieth day after irradiation (but in most cases twenty-three to twenty-eight days following irradiation) and lasted for thirty to forty days. After this time, all signs of the primary acute reaction had disappeared. Therefore the "zone of stimulation" can be observed only for a certain length of time, and in many cases, it is possible that this time is a very short one. But this temporary stimulating effect acts as a stimulus to new development. For example, the formation of a new tail has been observed in a number of cases. The beginning of this new tail formation was observed about seventy to seventy-five days after irradiation or after the end of primary acute reaction (Fig. 3). However, histological investigation showed that the first signs of new development (formation of the first cartilaginous element) occurred during the primary acute reaction to irradiation about forty-five to fifty days following irradiation. Usually this new tail formed from the dorsal and more proximal portion of the original tail. The growth of the distal portion of the original tail was arrested by treatment with a strong dose of roentgen rays. However, the proximal portion of the tail (boundary zone—"zone of stimulation"), which had received only a weak dose gave rise to a relatively well developed tail, which overshadowed, in its growth, the more heavily treated region. In animals whose tails were treated with large doses of

Fig. 3. The tail of an axolotl eighty-six days after irradiation with 2,000 r.

radiation in which the boundary zone had received a relatively larger dose, the newly developed tail had a slower rate of growth than the tails that had received smaller doses. Furthermore, this growth gradually became retarded and finally was arrested. On the contrary, after irradiation with smaller doses, development of a roentgen stimulated tail in the boundary zone continued for a very long time.

A morphological investigation of such an animal showed that the growth of the distal portion of the original tail was completely arrested and had a notochord of approximately the same size that it had on the day of irradiation. It is interesting to note that the skeleton of the new (stimulated) tail consisted entirely of cartilage. From the portion of the notochord which lay in the "zone of stimulation" there developed a cartilaginous projection which extended almost to the tip of the new (stimulated) tail. The cartilage was accompanied by a prolongation of the non-irradiated portion of the spinal cord. The irradiated portion of the spinal cord, because of its arrested growth was smaller in diameter than either the untreated or new (stimulated) portions of the cord (see Fig. 4*A*). A comparison of an animal such as the one just described with a normal control animal of the same age is reported in Figure 4. The distal tail skeleton of the control consists only of notochord. The first cartilaginous elements (supradorsale and infraventrale) develop much later, and in a normal animal of this

age cartilaginous elements are seen near the tail notochord only in its more proximal portions (Fig. 4*B*). The transformation of the notochord into cartilaginous and bony vertebrae occurs gradually and much later. But even in the vertebrae of the adult axolotl it is possible to see notochordal remnants. An investigation of the early stages of development of the new (stimulated) tails showed that the first new cartilaginous element, which later transformed into the cartilaginous skeleton of the stimulated tail, developed in the "zone of stimulation." Between this cartilaginous element and the normal cartilaginous elements more proximally, there was an interval in which no skeletal elements appeared. That is to say, the development of the new cartilaginous element occurred quite independent of the normal cartilaginous skeleton of the proximal region. It is obvious that the roentgen rays stimulated a new type of development, which differs markedly from the ordinarily normal type of development.

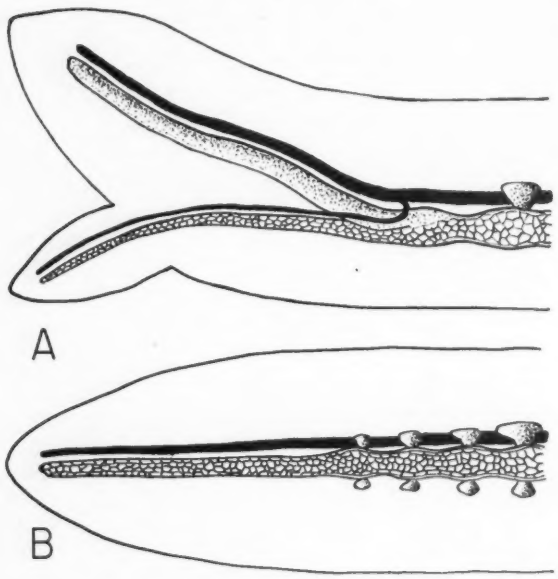


FIG. 4. Reconstructions of skeleton and neural tube in the tail region of the axolotl. *A*, tail of an animal seventy-five days after irradiation with 600 r; *B*, tail of a control animal of the same age (eighty-five days). In *A*, the lower portion of forked tail represents the original, irradiated tail; the upper portion is a new growth resulting from the stimulating effect of the irradiation.

It has been shown (Brunst[5]) that local irradiation of the lumbosacral region of young axolotls with even small doses (100–200 r) inhibit the process of development of the hind limb. This temporary inhibitory effect of small doses may be seen if one compares the size of irradiated limbs with that of controls. Larger doses (300–3,000 r) were found to completely arrest the development. In spite of the fact that the stimulating effect of small doses was not observed, another kind of stimulation was seen in a much later stage of development in the same material. The first signs of this stimulation were noted at the time when the acute primary reaction to irradiation had nearly subsided. In the boundary zone, there was observed an accumulation of small cells with many mitotic figures. Mitoses were observed also in the intestinal epithelium and in the ureteral epithelium. It was considered significant that, in this boundary zone, there was noted the beginning of a new development—the formation of an extremity bud with many mitotic figures (Fig. 5). Such buds were transformed into limbs which continued to grow for a long time. For example, one animal fixed 147 days after irradiation had two normal hind extremities and two additional ones caudal to them. The last pair was smaller and arose closer to the midline (Fig. 6). In this case, the stimulating effect was great enough not only for the production of limbs near the normal position, but even for the development of supernumerary limbs. The stimulating effect has been observed by the author in those cases where the animals were improperly oriented during irradiation. This was either a result of incorrect placement of the body or a little movement of the animal during irradiation which prevented the intended zone of irradiation (the lumbosacral region) from receiving all of its intended dosage. In consequence of this, the potentiality of limb formation was not suppressed by roentgen irradiation, but, on the contrary,

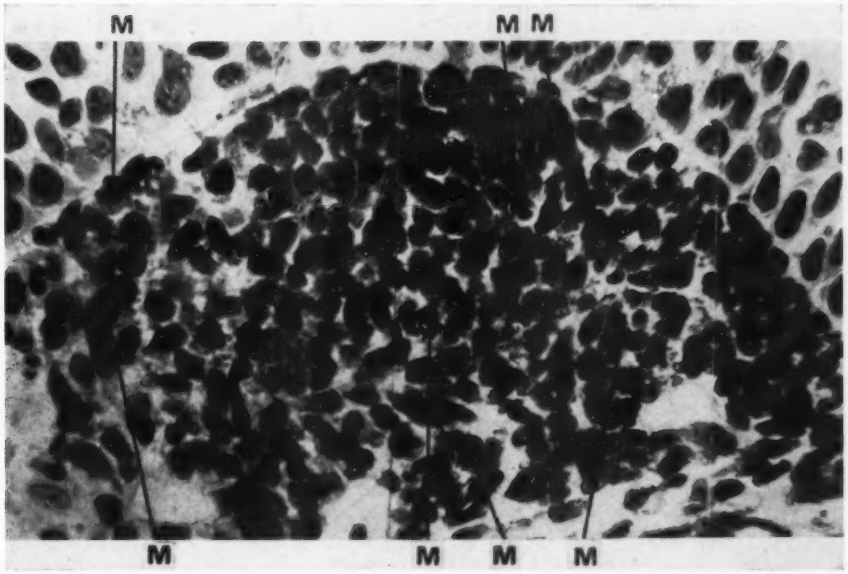


Fig. 5. Frontal section through the lumbosacral region of an animal forty-two days after irradiation with 750 r. *M*, mitotic figures. Photomicrograph ×322 (From V. V. Brunst, 1950.)

was stimulated by this treatment (Fig. 7). The stimulation of such a morphogenetic process occurs only in a region of the body which has the potentiality to form a new limb.

It is possible that this type of stimulation can be explained as a secondary effect induced by disintegration products (necrohormones), which form in the irradiated zone. According to Caspari,[8] Dustin,[14] Strelin,[58] Zawarzin,[62] and others, such stimulations were observed in some cases. Similar observations were made after the irradiation of *Triton cristatus* limbs (Brunst and Scheremetjewa,[6] Brunst[3]). In these cases the beginning of regeneration was observed after a period of reduction (Fig. 8). The authors explained this stimulation as a result of the influence of necrohormones, which accumulated during the reduction period. Abnormally thick epithelium (Fig. 9) was observed in the tail regenerate of tadpoles of *Pelobates fuscus* near the location of the necrotic epithelium (Scheremetjewa and Brunst[50]; see also: Stachowitz,[56] and Grasnick[20]). According to Czepa,[10] stimulation of interstitial cell growth after roentgen irradiation is the result of a necrohormone, which is formed in partially destroyed tissues of the testis. According to Weber[61] the same type of hormone is formed after the irradiation of plants.

It is possible that in all such cases, the stimulating effect is observed only after the accumulation of a sufficient quantity of disintegration products resulting from the destruction of irradiated cells (necrohormones or wound hormones).

It may be that the cancers which develop as a result of many small roentgen irradiations are also the result of the long

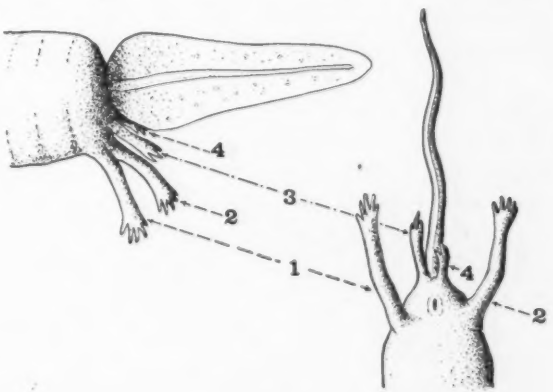


Fig. 6 Drawing of an axolotl which was fixed 147 days after local irradiation of the lumbosacral region with 1,500 r (viewed from lateral and below).

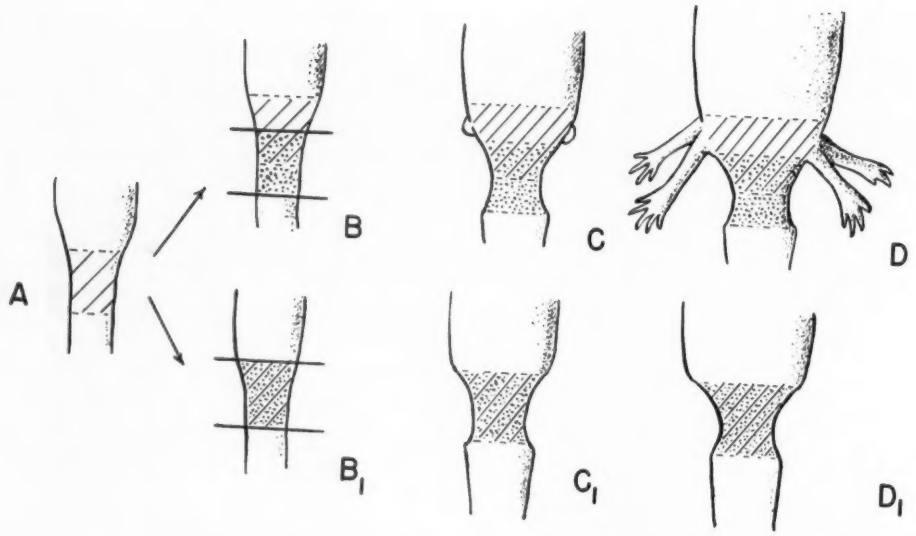


FIG. 7. Diagram showing the results of local irradiation of the lumbosacral region and the stimulation which occurs as a result of improper arrangement of the animal during irradiation. *B*, *C*, *D*, development of supernumerary limbs as a result of improper orientation of the animal during irradiation. B_1, C_1, D_1 suppression of development in cases of correct irradiation. Regions of the body which have the potentiality of limb formation are indicated by cross-hatching. Irradiated areas are indicated by stippling.

continued action of an accumulation of a sufficient quantity of necrohormones.

It is interesting to compare the development of supernumerary limbs after roentgen irradiation with a similar phenomenon which was described by Nassonov[42] after he had tied ligatures around the extremities of axolotls (Fig. 10). This formation of supernumerary limbs without amputation (superregeneration), was also observed in the proximal portion of the extremity and might be explained upon the basis of Nassonov's conclusion that the formation of disintegration products (necrohormones) is responsible for the stimulation of the regenerative process.

It seems clear that one can no longer ignore the phenomenon of roentgen stimu-

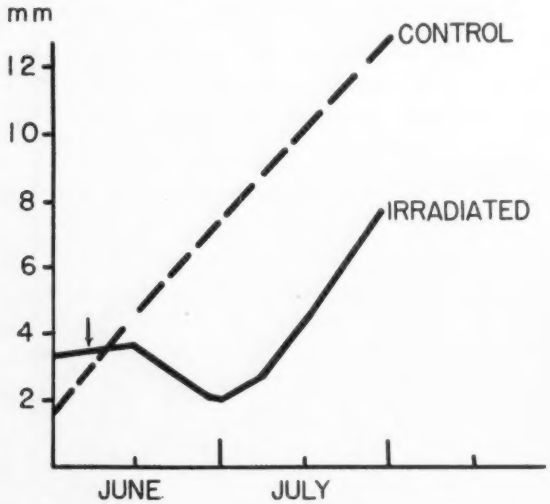


FIG. 8. Growth curve of an irradiated regenerating limb compared with that of a regenerating untreated limb of the same animal (*Triton cristatus*). Arrow denotes time of irradiation. (From V. V. Brunst and E. A. Scheremetjewa, 1933.)

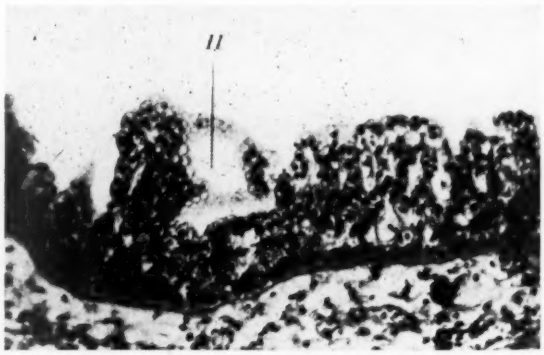


FIG. 9. Hypertrophy of epithelium on the ventral side of the tail of a *Pelobates fuscus* tadpole, twenty-six days after local irradiation with 3,750 r (From E. A. Scheremetjewa and V. V. Brunst, 1933.)

lation. Stimulation of mitotic activity by roentgen irradiation does occur, and can be observed in many cases. In future investigations, it is intended to extend the experiments just described and to set up other conditions in which the stimulating effects of roentgen irradiation may be observed and studied.

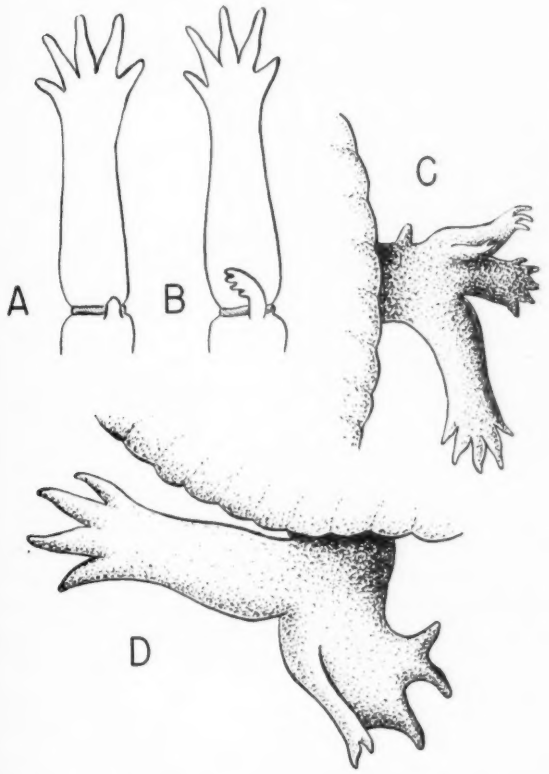


Fig. 10. Superregeneration occurring without amputation after ligation of the axolotl's limb. *A*, beginning of development of the limb bud in the proximal region of the extremity near the ligature. *B*, the same animal after two months. *C*, superregeneration thirteen months after ligation. *D*, superregeneration ten months after ligation. (From N. V. Nassonov, 1930.)

SUMMARY

A number of investigations have been described in which many cases of roentgen stimulation have occurred. For example, the stimulation of the development of additional tails or supernumerary limbs was observed in axolotls (amphibians) following roentgen irradiation. It is possible that, in many cases, this stimulation is a result of the effects of disintegration products of destroyed irradiated cells. This possibility that the roentgen stimulation was induced by necrohormones or wound hormones, was considered.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY, RADIUM THERAPY AND NUCLEAR MEDICINE

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Thirty-fifth Annual Meeting: St. Louis, Mo., April 19, 20, 21 and 22, 1953.

EDITORIAL

ROENTGENOGRAPHIC VISUALIZATION OF THE INTERVERTEBRAL DISC

SINCE 1937 there has grown up an extensive literature on backache and its relation to ruptures of the intervertebral disc. It was the investigations of Schmorl which stimulated the great interest in the nucleus pulposus and its herniation into the vertebral body. But Schmorl was not the first to demonstrate disc protrusion, as we know from the literature that Virchow in 1857 mentioned a cervical "ecchondrosis" with lethal compression of the spinal cord and the first description in the literature of disc rupture, as Lindblom[1] tells us, came one year later in a monograph by Luschka. There were, however, drawings of ruptured discs in earlier textbooks of anatomy: Weitbrecht's *Anatomie* of 1742 and Henle's *Bänderlehre* of 1856. However, these drawings were made to demonstrate the normal anatomy of the intervertebral disc, since the pathological condition was not recognized at that time. It was the work of Schmorl, which initiated the great interest in the intervertebral discs and the part they play in the normal physiology of the spine. But it remained for Mixter and Barr[2] to correlate the injuries of the intervertebral disc with symptoms of low back pain associated with sciatica and it was their splendid work which established this syndrome as a definite clinical entity.

The myelographic methods which have been employed in the roentgen diagnosis for demonstrating ruptured intervertebral discs are too well known to need comment. But, as all radiologists who have practiced this procedure appreciate, the myelographic method does not always reveal the true state of affairs; not infrequently, the radiologist may report a ruptured intervertebral disc with compression of the spinal cord to be confronted at the time of the operation with negative findings. Lindblom,[3] in appreciation of this fact and in an attempt to increase the diagnostic accuracy of rupture of the intervertebral disc, published a description of a method of direct injection of the intervertebral disc with a rapidly absorbable water-soluble contrast substance. He followed this publication of 1948 with another in 1950[4] giving the results of direct injection of the intervertebral disc with contrast medium in 52 cases, and he emphasized that this method, in his hands, was far superior to the myelographic method commonly employed in the diagnosis of ruptures of the intervertebral discs.

More recently, Gardner, Wise, Hughes, O'Connell and Weiford,[5] employing the method as suggested by Lindblom, have carried out his technique with certain modifications in a number of cases. In their study, 186 injections were attempted on 89 patients, and 169 satisfactory discograms were obtained. In 17 instances, satisfactory roentgenograms were not obtained because of failure to introduce the needle

[1] Lindblom, K. Backache and its relation to ruptures of the intervertebral disks. *Radiology*, 1951, *57*, 710–719.

[2] Mixter, W. J., and Barr, J. S. Rupture of intervertebral disc with involvement of spinal canal. *New England J. Med.*, 1934, *211*, 210–215.

[3] Lindblom, K. Diagnostic pucture of intervertebral disks in sciatica. *Acta orthop. Scandinav.*, 1948, *17*, 231–239.

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[5] Gardner, W. J., Wise, R. E., Hughes, C. R., O'Connell, F. B., Jr., and Weiford, E. C. X-ray visualization of the intervertebral disk; with a consideration of the morbidity of disk puncture. *A.M.A. Arch. Surg.*, March, 1952, *64*, 355–364.

into the disc; inability to inject the contrast medium; or rapid disappearance of the injected medium. Thirteen of these failures were at the fifth intervertebral space level. They also encountered certain difficulties in the procedure, namely, that in 12 per cent of the cases it was necessary to puncture the annulus more than once in order to obtain satisfactory positioning of the needle. They also observed that in the cases of disorganized disc the opaque medium (diodrast) may disappear in a matter of minutes, whereas in the normal disc traces of the opaque substance may be apparent on the roentgenogram as long as twelve hours after the injection.

Forty-eight cases were explored in which satisfactory discograms had been obtained. In 46 of these a diagnosis of posterior protrusion of mild to severe degree had been made from the roentgenographic studies. In 39 of these 46, a protrusion was found at surgery of sufficient degree to undoubtedly explain the patient's symptoms; and in the majority of these proved cases the patient's sciatic pain was reproduced by the injection of the disc at the time of the roentgenographic study, while in one-third of them the contrast medium was seen to have escaped into the epidural space. The protrusions of the disc were invariably at the level shown on the discograms. Interestingly enough, in 2 patients operated upon on the basis of the clinical picture, and despite negative discograms, protruded discs were not found.

In those discs on which satisfactory discograms had been obtained, 38 narrowed intervertebral spaces had been recorded on the plain roentgenograms. All of these showed degenerated discs with or without posterior protrusions. In 18 of the 39 surgically proved protruded discs, the involved intervertebral space was found to be narrowed on the plain roentgenograms.

Gardner and his associates carefully noted the morbidity of this procedure, namely, discography, carried out on their group of cases. Forty-one of the patients have been on conservative management for periods varying from one to seven months following discography and none of this group has returned with new or different symptoms which could be attributed to the injection of the disc. Only one patient thus far has suffered a complication from the injection.

It is well known that occasionally in lumbar punctures for therapeutic or diagnostic measures pathological changes in the intervertebral disc have occurred at the site of the lumbar puncture. Being aware of this, Gardner and his co-workers reviewed the reported cases of pathological changes in discs produced by lumbar puncture and they found that a high percentage had followed the intrathecal administration of antimeningococcic serum. A certain group of cases showing a disturbance of the disc followed meningitis and in these one or more lumbar punctures had been performed.

In the 58 case reports which they analyzed which implicated lumbar puncture as a cause of pathologic changes in lumbar discs, all of the cases presented certain features in common. The localized back pain and limitation of motion appeared to have been severer than is usually seen with protrusions of the nucleus pulposus. Interestingly enough, 37 of these 58 patients had meningitis at the time of the lumbar punctures. Most of the reported cases were also of infectious origin rather than due to simple trauma, as some authors suggest.

From their work on roentgenographic visualization of the intervertebral disc, Gardner and his co-workers found that by the injection of diodrast it is possible in a high percentage of cases to differentiate between a normal disc, a degenerated disc, and a degenerated disc with a posterior protrusion. However, in their hands, the procedure has not been entirely free of morbidity. They believe that increasing experience with this type of study should lead to greater accuracy in interpretation and better understanding of the disc syndrome. It has one virtue particularly in

that it provides a method of direct visualization of the pathologic process as contrasted with the indirect evidence offered by myelography. From their studies they concluded that it is too early as yet to determine the relative accuracy and morbidity of these two procedures, namely, myelography and discography.

Gardner and his group express the opinion that more experience is needed to establish the value of discography. They point to certain disadvantages of this procedure, namely, it is not free of morbidity; considerable care and experience are necessary in accomplishing the injection and in interpretating the results; and it may result in the overlooking of a tumor of the cauda equina which would have been readily disclosed by myelography.

Gardner and his co-workers have added considerably to the studies on discography initiated by Lindblom. Lindblom in his paper in 1950 clearly points out the indications for myelography and disc puncture when he says, "We know that lumbago and sciatica mean disc ruptures and protrusions. It is possible to localize them clinically and with the aid of myelography and disc puncture. Myelography and disc puncture are as a rule not needed for the diagnosis. They are procedures of a kind which should not be made unnecessarily but saved for the purpose of a preoperative localization." He further points out that it is worth remembering that disc cases heal without operation and he inveighs against the use of myelography as well as against disc puncture, except in definitely selected cases.

Studies of the type initiated by Lindblom and the work of Gardner and his associates have added materially to our knowledge of the intervertebral discs and their pathological processes. Further work along this line is clearly indicated and is anticipated with interest.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Shamrock Hotel, Houston, Texas, September 23, 24, 25 and 26, 1952.

AMERICAN RADIUM SOCIETY
Secretary, Dr. J. E. Wirth, 635 Herkimer St., Pasadena 1, Calif. Annual meeting: St. Louis, Mo., April 19–22, 1953.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y. Annual meeting: Netherland-Plaza Hotel, Cincinnati, Ohio, December 7 to 12, 1952.

AMERICAN COLLEGE OF RADIOLOGY
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich. Annual meeting: 1953, to be announced.

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

ARIZONA RADIOLOGICAL SOCIETY
Secretary, Dr. R. Lee Foster, 15 E. Monroe, Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

ATLANTA RADIOLOGICAL SOCIETY
Secretary, Dr. Albert A. Rayle, Jr., 478 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, October through April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. F. A. Riebel, 15 West Goodale St., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Columbus Athletic Club, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. B. D. Braun, 6 N. Michigan Ave., Chicago 2, Ill. Meets second Thursday of each month, October to April inclusive at the University Club.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Mortimer Lubert, 10515 Carnegie Ave., Cleveland 6, Ohio. Meetings at 6:45 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY
Secretary, Dr. W. P. Stampfli, 1933 Pearl St., Denver, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday October and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. J. C. Cook, Harper Hospital, Detroit, Mich. Meets monthly first Thursday, October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. A. Judson Graves, 2002 Park St., Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. Robert M. Tankesley, 218 Doctors Bldg., Atlanta, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

GREATER MIAMI RADIOLOGICAL SOCIETY
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HOUSTON RADIOLOGICAL SOCIETY
Secretary, Dr. F. M. Windrow, 1205 Hermann Professional Bldg., Houston, Texas. Meets fourth Monday each month.

IDAHO STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Alfred M. Stone, St. Lukes Hospital, Boise, Idaho. Meets annually at same time as Idaho State Medical Association.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. James McMillan, 1104 Bankers Trust Bldg., Des Moines, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific section is held in the autumn.

KANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Charles M. White, 3244 E. Douglas, Wichita 8, Kan. Meets annually with State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

KINGS COUNTY RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430 48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. John B. Hamilton, 210 N. Central Ave., Glendale 3, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MAINE RADIOLOGICAL SOCIETY
Secretary, Dr. C. F. Miller, Central Maine General Hospital, Lewiston, Maine.

* Secretaries of societies are requested to send timely information promptly to the Editor.

Miami Valley Radiological Society
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

Mid-Hudson Radiological Society
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 p.m., fourth Tuesday each month, September to May.

Milwaukee Roentgen Ray Society
Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. L. A. Nash, 572 Lowry Medical Arts Bldg., St. Paul 2, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

Mississippi Radiological Society
Secretary, Dr. John W. Evans, 621 High Street, Jackson 2, Miss. Meets third Thursday of each month at the Rotisserie Restaurant at 6:30 p.m.

Nassau Radiological Society
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Nebraska Radiological Society
Secretary, Dr. R. W. Blanchard, 1216 Medical Arts Bldg., Omaha, Nebr. Meets fourth Thursday of each month at 6 p.m. at Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Stanley M. Wyman, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Harvard Club.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Irving Schwartz, 45 E. 66th St., New York 21, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 p.m.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings by announcement.

Northeastern New York Radiological Society
Secretary, Dr. John F. Roach, Albany Hospital, Albany, N. Y. Meets on the second Wednesday of October, November and March at the University Club, Albany. Annual meeting in June to be announced.

Northern California Radiological Club
Secretary, Dr. G. A. Fricker, Sacramento County Hospital, Sacramento, Calif. Meets at dinner last Monday, every second month, except June, July and August.

Ohio State Radiological Society
Secretary, Dr. Willis S. Peck, 2001 Collingwood Blvd., Toledo, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. John R. Danstrom, Medical Arts Bldg., Oklahoma City, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. J. Richard Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets monthly from October to June on the second Wednesday of each month at 8:00 p.m. at the University Club.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. George P. Keefer, American Oncologic Hospital, Philadelphia 4, Pa. Meets first Thursday of each month, at 5 p.m., from October to May in Thompson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. E. J. Euphrat, 3500 Fifth Ave., Pittsburgh 13, Pa. Meets 6:30 p.m. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Richard B. Hanchett, 705-6 Medical Arts Bldg., Baltimore, Md. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Fred. Zaff, 135 Whitney Ave., New Haven, Conn. Meets bimonthly on second Wednesday.

Radiological Section, Medical Society of the District of Columbia
Secretary, Dr. U. V. Wilcox, 915 Nineteenth St., N. W., Washington 6, D. C. Meets Medical Society Library, third Thursday of January, March, May and October at 8:00 p.m.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of Greater Cincinnati
Secretary, Dr. Harry K. Hines, 2508 Auburn Ave., Cincinnati 19, Ohio. Meets monthly from September to June on first Monday of each month at 7:30 p.m. at the Cincinnati General Hospital.

Radiological Society of Hawaii
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Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Radiological Society of New Jersey
Secretary, Dr. Nicholas G. Demy, 912 Prospect Avenue, Plainfield, N. J. Meets annually at Atlantic City at time of State Medical Society and mid-winter at Elizabeth, N. J.

Richmond County Radiological Society
Secretary, Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Robert J. Bloor, 260 Crittenden Blvd., Rochester, N. Y. Meets last Monday of each month, September through May, at Strong Memorial Hospital.

Rocky Mountain Radiological Society
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St. Louis Society of Radiologists
Secretary, Dr. Francis O. Trotter, Jr., 634 N. Grand Blvd., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August and September.

San Antonio-Military Radiological Society
Secretary, Dr. Hugo F. Elmendorf, Jr., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets Brook Army Medical Center Officers Mess first Monday of each month.

San Diego Radiological Society
Secretary, Dr. Rex Uncapher, 7720 Girard Ave., La Jolla, Calif. Meets first Wednesday of each month at the University Club.

San Francisco Radiological Society
Secretary, Dr. I. J. Miller, 2680 Ocean Avenue, San Francisco 27, Calif. Meets quarterly.

Section on Radiology. California Medical Association
Secretary, Dr. Calvin L. Stewart, 2330 First Ave., San Diego 1, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 p.m., September to May inclusive.

South Bay Radiological Society
Secretary, Dr. Ford Shepherd, 526 Soquel Avenue, Santa Cruz, Calif. Meets second Wednesday each month.

South Carolina X-Ray Society
Secretary, Dr. Henry E. Plenge, Spartanburg General Hospital, Spartanburg, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, Newell Hospital, Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting: San Antonio, Texas, January 23 and 24, 1953.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7:00 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. John N. Burkey, 555 Medical-Dental Bldg., Seattle 1, Wash. Meets fourth Monday of each month from September through May.

Westchester Radiological Society
Secretary, Dr. Walter J. Brown, Northern Westchester Hospital, Mt. Kisco, N. Y. Meets on third Tuesdays of January and October and on two other dates to be announced.

Wisconsin Radiological Society
Secretary, Dr. Irving I. Cowan, 425 E. Wisconsin Ave., Milwaukee 2, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. Charles E. Duisenberg, Palo Alto Clinic, 300 Homer Ave., Palo Alto, Calif. Meets third Thursday at 7:45 P.M., January to June, Lane Hall, Stanford University Hospital; July to December, San Francisco Hospital.

Cuba, Mexico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary-Treasurer, Dr. Jean Bouchard, Suite 305, 1555 Summerhill Avenue, Montreal 26, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Française d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. R. deG. Burnard, 170 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179 B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Asociacion Argentina de Radiologia
Secretary, Dr. Lidio G. Mocsa, Avda. Gral Paz 151, Córdoba, Argentina. Meetings held monthly.

Sociedad Argentina de Radiologia, Junta Central, Buenos Aires
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

Sociedad Argentina de Radiologia, Filial del Litoral, Sede, Rosario
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

Sociedad Argentina de Radiologia, Filial del Sur, Sede, La Plata
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Centro, Sede, Cordoba
President, Prof. Dr. David L. Caro, Corro 86, Cordoba. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Norte, Sede, Tucuman
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

Sociedad Argentina de Radiologia, Filial de Cuyo Sede, Mendoza.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Colombiana de Radiologia
Secretary, Dr. Alberto Torres Focke, Av. 34, No. 17–34, Bogota, Colombia. Meets last Wednesday of each month.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Allies, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Société Française d'Electro-Radiologie Médicale, and its branches: Société du Sud-Ouest, du Littoral Méditerranéen, du Centre et du Lyonnais, de l'Ouest, de l'Est, et d'Alger et d'Afrique du Nord
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IX^{e}, France.

Ceskoslovensk společnost pro rëntgenologii a Radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

Deutsche Roentgen-Gesellschaft
Secretary, Dr. Peter Kröker, (22a) Essen-Helsingen, Westpreussenstrasse 21. Meets annually in different towns.

Societa Italiana dr Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

India

Indian Radiological Association
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

The Thirty-eighth Annual Meeting of the Radiological Society of North American will be held at the Netherland-Plaza Hotel, Cincinnati, Ohio, December 7–12, 1952. Scientific sessions, refresher courses, scientific exhibits and commercial exhibits will form a part of each day's activity.

At the Cincinnati meeting, the Radiological Society of North America will undertake for the first time a broad expansion of its scientific program. Emphasis will be placed on the work being carried out in fields closely associated with radiology, such as, radiation-physics, radiation-biology and radiation-chemistry. In addition to the usual sessions, which will be held in the Netherland-Plaza Hotel, there will be parallel sessions held at the Sheraton-Gibson Hotel during the mornings of Tuesday through Friday. These sessions will include twelve refresher courses in the general fields of radiation-physics, biology and chemistry, together with some highly specialized problems in therapy.

Following the refresher courses will be scientific sessions during which four or five papers, per morning, will be given on subjects in these borderline fields.

There will be a registration fee of $15.00 for all non-members of the Society. The registration fee will include the cost of the Refresher Courses. Those exempt from paying the registration fee are: residents and interns in radiology; trainees in physics; members of the Armed Forces on temporary duty; guest speakers on the program; and guest instructors giving refresher courses.

Hotel reservations should be made by writing to the Housing Bureau, The Radiological Society of North America, 910 Dixie Terminal Building, Cincinnati 2, Ohio.

CANCER SEMINAR

The Fourth Annual Cancer Seminar will be held in Colorado Springs, Colorado, on September 6, 1952, at the Broadmoor Hotel under the sponsorship of the Penrose Cancer Hospital and the College of American Pathologists.

This year the Seminar will be devoted to gastrointestinal lesions. Guest speakers will be Dr. Leo G. Rigler, Professor of Radiology, University of Minnesota, and Dr. Lauren V. Ackerman, Professor of Surgical Pathology, Washington University. Approximately fourteen problem cases will be discussed. Participants in the meeting will receive advance material for study and to submit their diagnostic impressions.

All those interested in attending should write to Dr. James W. McMullen, Penrose Cancer Hospital, 2200 North Cascade Avenue, Colorado Springs, Colorado.

NEW OFFICERS OF THE AMERICAN RADIUM SOCIETY

At the Thirty-fourth Annual Meeting of the American Radium Society held at the Conrad Hilton Hotel, Chicago, Illinois, June 8, 9, and 10, 1952, the following officers were elected for the coming year: *President*, Dr. Howard B. Hunt, Omaha, Nebr.; *President-Elect*, Dr. Edith H. Quimby, New York, N. Y.; *1st Vice-President*, Dr. Wendell G. Scott, St. Louis, Mo.; *2nd Vice-President*, Dr. James E. Breed, Chicago, Ill.; *Secretary*, Dr. John E. Wirth (re-elected), Pasadena, Calif.; *Treasurer*, Dr. Grant H. Beckstrand (re-elected), Long Beach, Calif.

The Thirty-fifth Annual Meeting of the American Radium Society will be held in St. Louis, Missouri, April 19–22, 1953.

SYMPOSIUM ON FUNDAMENTAL CANCER RESEARCH

The Sixth Annual Symposium on Fundamental Cancer Research sponsored by the University of Texas, M. D. Anderson Hospital for Cancer Research, was held in Houston, Texas, April 25 and 26, 1952. Meeting jointly with the South Central Region College of American Pathologists, the Texas Society of Pathologists, and the Houston Society of Pathologists, the Symposium drew an attendance of about 300 persons coming from twenty-two states and Mexico. The meeting was divided into three major sections: a panel on nutritional factors in cancer research; a cancer pathology and radiology conference; and a session devoted to fundamental cancer research. Dr. M. M. Wintrobe of the University of Utah College of Medicine arranged the program for the nutrition panel.

Highlight of the Symposium was the presentation of the annual Bertner Foundation Award posthumously to Dr. George Milton Smith in recognition of his lifetime achievements as an organizer and administrator of cancer research. The annual Bertner Lecture was given by Dr. Stanhope Bayne-Jones of New York Hospital-

Cornell Medical Center; his subject was "Aspects of Cancer Research in the United States." The Bertner Award and Lecture are given annually in honor of the late Dr. E. W. Bertner, first acting director of the M. D. Anderson Hospital, who spent the greater part of his life in the field of cancer control.

Also announced at the Symposium was the award of the Jesse H. Jones Fellowships in Cancer Education, given in honor of Dr. Bertner. The fellowships went to Dr. Robert J. Peace for advanced study in pathology at the M. D. Anderson Hospital, and to Dr. Franklin T. Brayer for study in experimental medicine at the Memorial Hospital for Cancer and Allied Diseases, New York.

SECTION ON RADIOLOGY OF THE CALIFORNIA MEDICAL ASSOCIATION

The following are the officers of the Section on Radiology of the California Medical Association for the year beginning April, 1952, through April, 1953: *Chairman of the Radiology Section*, Dr. Robert K. Arbuckle, Oakland; *Secretary*, Dr. Calvin L. Stewart, 2330 First Avenue, San Diego 1, California; *Assistant Secretary*, Dr. H. R. Morris, Redlands.

NEW ENGLAND ROENTGEN RAY SOCIETY

At the annual meeting of the New England Roentgen Ray Society held at the Hotel Somerset on Friday evening, May 16, 1952, the following officers were elected to serve for 1952–1953; *President*, Dr. Douglas J. Roberts, Hartford, Connecticut; *Vice-President*, Dr. William S. Altman, Quincy, Massachusetts; *Secretary*, Dr. Stanley M. Wyman, Massachusetts General Hospital, Boston, Massachusetts; *Treasurer*, Dr. Magnus I. Smedal, Boston, Massachusetts.

OKLAHOMA STATE RADIOLOGICAL SOCIETY

On May 2, 1952, the Oklahoma State Radiological Society held a meeting at which time the following officers were elected for a two year term: *President*, Dr. Walter E. Brown, Tulsa; *Vice-President*, Dr. Edward D. Greenberger, McAlester; *Secretary-Treasurer*, Dr. John R. Danstrom, Medical Arts Building, Oklahoma City, Oklahoma.

PACIFIC ROENTGEN SOCIETY

The annual meeting of the Pacific Roentgen Society was held during the annual convention of the California Medical Association, Los Angeles, in April, 1952. The following officers were elected: *Chairman*, Dr. A. K. Merchant, Stockton; *Member of the Executive Committee*, Dr. Roy W. Johnson, Los Angeles; *Secretary-Treasurer*, Dr. L. H. Garland, 450 Sutter Street, San Francisco, California. There are now 275 members of the Society. The guest speaker of the Section on Radiology of the State Medical Association was Dr. E. P. Pendergrass of Philadelphia.

TENNESSEE RADIOLOGICAL SOCIETY

At the recent annual meeting of the Tennessee Radiological Society, the following officers were elected for the year 1952–1953: *President*, Dr. J. E. Whiteleather, Memphis; *Vice-President*, Dr. Joseph McKinney Ivie, Nashville; *Secretary-Treasurer*, Dr. J. Marsh Frère, Newell Hospital, Chattanooga 2, Tennessee.

ACADEMY HONORS DR. LAWRENCE A. POMEROY

Dr. Lawrence A. Pomeroy of Cleveland, Ohio, pioneer in cancer control activities in Ohio and former President of the Academy of Medicine of Cleveland, received the Academy's Distinguished Service Award for 1952 at its annual meeting on the evening of May 16, 1952. The citation was read by Dr. Francis Bayless, President of the Academy, and is quoted in part as follows:

"Dr. Lawrence A. Pomeroy, distinguished citizen of Cleveland, faithful member of the Academy and pioneer in the community control of cancer, the Academy of Medicine honors itself and Cleveland by bestowing upon you on the occasion of its Fiftieth Annual Meeting, the Academy's 1952 Distinguished Service Award.

"A Cleveland citizen by birth, the son of a physician, a graduate of our own Medical School of Western Reserve University, and an interne and resident in our Lakeside Hospital, your professional career has been continuously interwoven with the development of medicine and public health in this city and state.

"With pride we recall the many years in which you have been an active worker in the Academy, serving as Chairman of nine committees, as Editor-in-Chief of the *Bulletin*, as a member of Council and the Board of Directors, as Vice President, and finally in 1927 as President. While President it was your pleasure to appoint the Academy's first Committee on Health Education, a field to which medical organization locally and nationally has since dedicated itself.

"While finding time for all of your devoted attention to the affairs of the Academy, you still had hours to serve our companion society, the Cleveland Medical Library Association as a member of many committees, its Board of Trustees (in which you are still an emeritus member), as Secretary, and finally in 1946 and 1947 as President.

"Your interest in the problems of cancer led you far beyond the care of your individual patients to the community consideration of cancer and the need for early detection. Largely through your efforts the first Tumor Clinic in Cleveland was established in City Hospital in 1925. . . .

"In March, 1951, you were presented with the Distinguished Service Medal of the American Cancer Society at its annual meeting in Cleveland. We can do no better than to end this citation with a quotation from one of the participants in this ceremony, Dr. E. O. Swartz, President of the Ohio State Medical Association, who said, 'Dr. Pomeroy has been one of the guiding spirits in the development of the present program. He has done much to bring about a harmonious understanding and a practical working agreement between the medical profession, the public and the American Cancer Society. . . . He is recognized both in this country and abroad as one of the outstanding authorities on the treatment of cancer of the cervix.'"

Dr. Pomeroy is a Diplomate of the American Board of Radiology and an honored, longtime member of the American Radium Society and other specialized societies.

RADIOISOTOPES FOR CANCER PROGRAM

The U. S. Atomic Energy Commission, in fiscal year 1953 (July 1, 1952 through June 30, 1953), is changing its previous policy of distributing radioisotopes for cancer research and therapy free of production costs. Instead, it will make a charge of 20 per cent of production costs. This change in policy affects only the price, and not the availability of isotopes; production will continue to meet all demands.

In 1948 the Atomic Energy Commission initiated a balanced program for utilization of its special facilities and knowledge in the field of cancer research. As part of this program, radioactive sodium, phosphorus and iodine were made available free of production costs for use in the study, diagnosis and treatment of cancer and allied diseases. The following year the program was enlarged to include other radioisotopes distributed by the Commission, provided the materials were to be used in cancer studies or treatment.

Other phases of the Commission's cancer program have been carried forward simultaneously with the isotopes-distribution program. For example, the Oak Ridge and Argonne Cancer Hospitals have been established, and beds have been set aside in the hospital at Brookhaven National Laboratory for experimental work in cancer.

A number of cancer research projects, concerned with the application of particular radioisotopes to cancer diagnosis and treatment, have been and are being conducted under AEC contracts at various institutions. Studies of radiation localization in tissues and of methods of making radioactive agents deposit selectively in cancerous sites within the body have been carried forward. Research involving the use of particle accelerators has been conducted, and thousand-curie sources of gamma radiation have been developed for use in cancer and other studies.

Distribution of radioisotopes free of production costs for cancer studies has proved an extremely helpful and valuable program, as evidenced by the fact that it has expanded rapidly and is continuing to expand. The program has fulfilled its objective of providing a strong stimulus to the fullest possible exploration of the usefulness of radioisotopes in cancer studies.

The field has developed so rapidly that certain clinical applications of radioisotopes have now become a matter of routine, and research workers have become fully aware of the usefulness of these atomic tools in cancer research. The Commission's Advisory Committee for Biology and Medicine and Advisory Committee on Isotopes Distribution recently have advised that the stimulus of completely free distribution no longer is necessary to encourage the use of radioisotopes in the field of cancer. These committees have agreed with the view of the AEC that a charge of 20 per cent of catalog prices will not hamper advances in this field, and that it will help to indicate the future demand for radioisotopes in relation to other tools for cancer research and therapy.

Radioisotopes are being used in the study of a number of other diseases, such as heart disease and hyperthyroidism, as well as in the study of cancer. However, the full production

cost has been charged for radioisotopes used in studies of diseases other than cancer.

The following table shows the prices per millicurie which will be charged, beginning July 1, 1952, for the four most important radioisotopes used in cancer research or therapy, compared with prices for non-cancer use:

	Cancer Use	*Non-Cancer Use*
Radioiodine 131	$0.15	$ 0.75
Radiophosphorus 32	0.22	1.10
Radiogold 198	0.05	0.24
Radiocarbon 14	7.20	36.00

Application Procedure

Under the new policy, radioisotopes will be distributed by the AEC and AEC distributors from July 1, 1952, through June 30, 1953, at a reduction of 80 per cent from the AEC catalog price, within the following limitations:

Cancer Research. All radioisotopes will be available at the reduced price for this purpose. Cancer research is interpreted to mean the following:

1. Investigations of the basic aspects of normal and abnormal cellular growth.
2. Development and evaluation of therapeutic and diagnostic procedures for cancer and allied diseases.

Cancer Diagnosis and Therapy. Radiophosphorus 32, radioiodine 131 and radiogold 198 will be distributed at the reduced price for use in routine or non-experimental diagnosis and treatment of cancer and allied diseases. (Radioisotopes for treatment of non-malignant diseases—such as hyperthyroidism and cardiac decompensation—are *not* included in this program. Separate application forms should be submitted to obtain materials for non-cancer uses.) Radioactive material for fixed sources such as Co 60 and Cs 137 are not included under this arrangement.

Chemical or Biological Synthesis in the Applicant's Laboratory. All the activity to be used in the synthesis of a radioisotope-labeled compound will be distributed at the reduced price provided:

1. The labeled compound is for cancer research, diagnosis or therapy, within the applicant institution.
2. The synthesis is performed in the applicant's laboratories.

Processing or Synthesis by a Supplier. A suplier,* who has delivered processed radioisotopes to a person holding an authorization to receive radioisotopes at the reduced price for cancer, may submit an application for replacement, at the reduced price, of the activity delivered provided the original activity was obtained from the AEC or an AEC distributor.* The application for replacement must include:

1. Reference to the supplier's original authorization number
2. Name of customer
3. Customer's authorization number
4. Quantity delivered
5. Date delivered
6. Evidence of price reduction to purchasers of radioisotopes for approved cancer research, diagnosis and therapy.

Application Procedure. In applying for an authorization to receive radioisotopes under the program outlined herein, the applicant is requested to:

1. Complete an "Application for Radioisotope Procurement," Form AEC-313, for each radioisotope requested.
2. In addition to the prescribed information include the following in Item 11, "Statement of Use," or on an attached sheet:
   a. The statement "This application is for a radioisotope to be procured at a reduction of 80 per cent from the AEC or AEC distributed catalog price and to be used in cancer . . . (research, diagnosis, therapy)."
   b. The statement "The work will (will not) be done under a contract with the Atomic Energy Commission." Give contract number, if any.

Any "Authorization for Radioisotope Procurement," Form AEC-374, issued under this program will expire at the end of the fiscal year—June 30, 1953—unless sooner terminated by the Commission.

The phrase "reduction of 80 per cent from AEC catalog price" means the authorized person may purchase radioisotopes, except synthesized labeled compounds, at 20 per cent of the price listed in a catalog issued by the Commission or a distributor. Each shipment from a Commission distributor will be subject to the regular handling charge made to cover costs of packaging, monitoring and accounting. Transportation charges will be paid by the purchaser.

* "Distributors" currently are (1) Oak Ridge National Laboratory, Oak Ridge, Tennessee; (2) Brookhaven National Laboratory, Upton, Long Island, New York; and (3) Argonne National Laboratory, Chicago, Illinois.

"Suppliers" are any other persons or firms who furnish radioisotopes on authorization of the Commission.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

Die gesunde und kranke Wirbelsäule in Röntgenbild und Klinik. Pathologisch-anatomische Untersuchungen. Von Geh. Med.-Rat Prof. Dr. med. et Dr. med. vet. h.c. Georg Schmorl (†1932). Für Röntgenkunde und Klinik bearbeitet von Prof. Dr. med. habil. Herbert Junghanns, Oldenburg (Oldb.). Zweite, wesentlich erweiterte Auflage. Cloth. Price, DM 69.-. Pp. 284, with 399 illustrations. Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1951.

The first edition of this monograph, published in 1932, has been a powerful stimulus to the progress which has been made in the understanding and treatment of vertebral disease during the past two decades. The information which it offered on the normal and morbid anatomy of the intervertebral disc, the interrelations of disc and bone lesions, and on the development of the spine and its variants was new and beautifully documented. Other abnormalities, such as tumors, infections and metabolic disorders, were presented less completely. The book was not so much a treatise of vertebral pathology as an often enlightening account of fundamental pathologic mechanisms and of the roentgen images which they produce; it thus added strength to the foundations of roentgen interpretation. The clinical aspects of the matter were not within its scope.

Apparently the need for clinical correlations has been felt by the co-author, Dr. Junghanns, who is the editor of the second edition, since the words "und Klinik" (and clinical use) have been added to both the title and subtitle of the book. References to clinical manifestations are made here and there, especially in the revised chapter on posterior herniation of the disc, but most of the text remains confined to a description of morphologic changes without reference to their clinical significance or lack of significance. The emphasis is still on those data and concepts which were so well presented in the first edition. Over one hundred pages are assigned to the various senile and "degenerative" vertebral changes, while primary and metastatic tumors are dealt with in ten; vertebral arthritis, as distinct from senile and postural alterations, is summarized in a brief chapter; parathyroidism, renal rickets and the anemias are hardly mentioned, and the differential diagnosis of significant findings is not considered. Some of the new material consists mainly of references to the names of authors without discussion of their findings. The wealth of information which this book contains is partly inaccessible because of the absence of an index. The bibliography is profuse, but fails to list many a representative publication while citing less important papers of the same authors. In brief, the new edition, while adding some new material, has failed to place it in its proper perspective and has thereby obscured the clarity and consistency of the first.

The book is well printed and beautifully illustrated. The juxtaposition of specimens and their roentgen images, which was one of the best features of the first edition, has been maintained, and all of the pictorial material, old and new, is instructive and often revealing. In the new edition, the monograph remains an outstanding study of important aspects of the pathology of the spine; but in spite of the change of title it is not a textbook or reference work for clinical use. It is still primarily a record of Schmorl's superb investigations; as such, it retains its basic value for those who deal with the pathology, surgery and radiology of the spine.

Albert Oppenheimer, M.D.

Abdominal Distension and Intestinal Activity Following Laparatomy. A study of the "postoperative abdomen," especially the roentgenological findings after herniotomy, appendectomy and gynecological operations. Acta radiologica, Supplementum LXXXIII. By Andreas Høyer. Paper. Price, Sw. Cr. 15:-. Pp. 207, with 35 illustrations and 55 tables. Nationaltrykkeriet, Oslo, Norway, 1950.

This book, which appeared as a supplement to *Acta radiologica*, describes the author's roentgenologic and clinical investigations of what is

called the "postoperative abdomen." The book is divided into two parts. In the first part the author reviews the literature concerning intestinal gas, its causes and distribution, intestinal activity and peristalsis, and abdominal distention after laparotomy. In the second part he details his own methods of study and reports his results. An appendix contains 15 tables summarizing the reports of the 125 operative and 61 control cases which formed the author's material. There is also a bibliography of some 240 references.

In the final chapter, questions are answered regarding the incidence and duration of postoperative abdominal distention, the distribution of gas in the intestines, the role of roentgenology in the postoperative examination of the patient, and the distinction between postoperative distention and mechanical obstruction of the small intestine.

The book is replete with detailed tables, graphs and charts. More than 75 roentgenograms are reproduced in figures of good quality.

Although there is much repetition in the book, made necessary by the arbitrary separation of the author's material from the reports of investigations by others, the volume can be recommended to all those who have a particular interest in a study of the abdomen after laparotomy. The report is too detailed to be of interest to the average surgeon, internist or radiologist.

C. Allen Good, M.D.

Diagnosis and Treatment of Menstrual Disorders and Sterility. By Charles Mazer, M.D., F.A.C.S., Formerly Associate Professor of Gynecology and Obstetrics, Graduate School of Medicine, University of Pennsylvania; Attending Gynecologist, St. Agnes Hospital; Consulting Gynecologist, Mount Sinai Hospital, Philadelphia; and S. Leon Israel, M.D., F.A.C.S., Assistant Professor of Gynecology and Obstetrics, Graduate School of Medicine, University of Pennsylvania; Attending Gynecologist, Mount Sinai Hospital, Philadelphia. Third edition, revised. Cloth. Price, $10.00. Pp. 583, with 115 illustrations. Paul B. Hoeber, Inc., 49 East 33rd Street, New York 16, New York, 1951.

This is the third, completely revised edition of "Diagnosis and Treatment of Menstrual Disorders and Sterility." Like its predecessors, the thirty-three chapters which make up this text were written to bring information on these subjects for practical application by the family physician in his office routine. As such, it emphasizes chiefly those procedures which the authors have found useful in the care of their own patients and which they recommend on the basis of their own experience. In this respect it is a highly personal book.

Taken as a whole, the material is well presented and generally acceptable. Readers of these pages will be most interested to learn their views on the value of "low dosage" roentgen stimulation of the ovaries and/or pituitary for various disturbances of menstruation. As is well known, the authors of this text are among the more enthusiastic advocates of this method of therapy. Their recognition, however, that "the margin between the harmless and harmful dose is limited" causes them to emphasize the prime importance of a carefully executed technique controlled by a trained radiologist. Despite their realization of the narrow margin of safety in subjecting the ovaries even to "low dosage" irradiation, the authors suggest its usefulness in a rather wide variety of conditions, such as premenstrual tension, dysmenorrhea in irregular cycles, hypomenorrhea following periods of amenorrhea, mazoplasia of the breasts and dysfunctional bleeding. Not all will share their enthusiasm for irradiation in these conditions. In the presence of pituitary-ovarian failure, however, there is little reason to question this method since there is much to be gained and apparently little to lose. The authors report that "only 10 of 473 amenorrheal patients so treated experienced an aggravation of the amenorrhea." The authors further claim that preconception irradiation of the ovaries is harmless, whereas they warn that postconception irradiation may have deleterious effects upon the offspring. In their advocacy of intrauterine radium therapy for premenopausal bleeding, the authors make light of recent attempts to ascribe carcinogenic properties to radium. Of further interest to radiologists are the recommendations of hysterosalpingography in the study of infertility and sterility. In addition to yielding important diagnostic information, the possible therapeutic value of lipiodol in cases of tubal occlusion is suggested.

Other readers of this text will find much with which to agree as well as disagree. The importance of careful exclusion of organic as well as

systemic causes of menstrual disorders and sterility before resorting to endocrine therapy is well discussed. The chapters devoted to the practical aspects of infertility in the male as well as in the female are brief but informative. The authors treat too lightly, however, the "legal formalities" involved in heterologous artificial insemination. The family physician should know that its status before the law has not been completely clarified. In this same discussion (p. 449) an inconsistency is noted in the appraisal of the Farris test for ovulation which previously (p. 421) had been questioned. Most obstetricians, while supporting the importance of thyroid therapy in pregnancy when indicated, will regard as superfluous the recommendation (p. 529) that "monthly estimation of the basal metabolic rate is an essential routine procedure during the entire period of gestation."

Despite inevitable disagreements with some viewpoints expressed by the authors, this book will be read with interest and profit by those who are interested in these complicated and as yet incompletely explored clinical fields. The text concludes with an appendix listing commercially available endocrine products recommended for the treatment of menstrual dysfunctions and sterility.

Harold C. Mack, M.D.

Die Entzündungsbestrahlung. Von Dr. med. habil. R. Glauner, Dozent für Röntgenologie und Strahlenheilkunde, Chefarzt der Röntgenabteilung am Marienhospital, Stuttgart. 2. Auflage. Cloth. Price, DM 18.60/$4.45. Pp. 189, with 17 illustrations and 10 tables. Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1951.

The first edition of this monograph was published in 1940; the completed second edition was destroyed in 1943 during a bombardment of the publishers' headquarters in Leipzig. In view of the changes brought about by the development of the sulfonamides and antibiotics, the author decided to postpone the preparation of a new edition until sufficient experience as to the therapeutic effect of these new drugs had been accumulated to determine their influence on the indications for roentgen therapy in inflammatory diseases. While the first general part needed practically no changes, the second or special section had to be completely revised.

A historical chapter brings out the fact that roentgen rays were used in the treatment of inflammations as early as 1898 and L. Freund reported in 1903 his experience in the treatment of blepharitis, acne vulgaris and a case of furunculosis.

The term "inflammation" is defined in a brief section followed by a discussion of the effect of roentgen rays on local inflammatory processes, their effect on the causative agents of inflammations, on the general antibody reactions, the clinical course of an inflammatory process produced experimentally and the influence of irradiation on the course of the inflammatory process. Indications and contraindications are likewise outlined. An analysis of the experimental and clinical facts seems to point out that the basic effect of irradiation on an inflammation must be seen in the change of the actual tissue reaction; in other words, the acidosis present in the early stage is changed towards the alkaline side. The effect is in all probability due to a destruction of highly radiosensitive cells, as for instance, leukocytes and lymphocytes. This may produce increased fermentative reactions both at the site of the inflammation and at distant points. It is very likely that the effect of irradiation on blood vessels plays a role in the beneficial action; it relieves spasm and local hyperemia.

The quality of the radiation has apparently little influence on the end results to be expected. It is most important to use the smallest dose necessary to achieve the therapeutic aim. The sooner the inflammatory process is irradiated after its development, the more striking is the response. Chronic processes require higher doses. It is possible to see a definite effect with as little as 10 r, although the author states that the average doses vary between 50 and 150 r per treatment per field. The port of entry should be large enough to exceed the actually inflamed area. In some instances small doses may be given daily; chronic cases requiring doses as high as 200 r should not be treated oftener than every three days. It is inadvisable to irradiate an acute inflammatory process more than three or four times.

The clinical section deals with inflammatory diseases in the skin, the lymphatic tissue, the oral cavity, nose, sinuses, ear and eye, bones and joints, blood vessels, genitourinary system, in gynecology, in the central and peripheral nervous system, in the peritoneal cavity and

with miscellaneous diseases which include diphtheria carriers, gas gangrene, human bites and spurs of the calcaneus with inflammatory changes. A brief section on tuberculosis concludes this part of the book.

While in the majority of inflammatory processes, if seen early, satisfactory results may be expected, roentgen rays have no longer any place in the treatment of erysipelas. The same holds true for lobar pneumonia except for a few chronic cases which do not resolve easily. Arthritis, orchitis, etc., on the basis of gonorrhea which used to be subject to roentgen therapy are no longer treated. In tuberculosis where roentgen therapy was widely used on the Continent it is no longer employed except in cervical lymphadenitis. A bibliography containing mostly German references is appended.

It is the reviewer's opinion that every radiologist interested in this subject would benefit by reading this most complete treatise on roentgen therapy of inflammatory diseases.

E. A. Pohle, M.D.

La malattia sclerodermica. By Guido Bassi. Prefazioni del Prof. Giovanni di Guglielmo. Cloth. Pp. 701, with 185 illustrations. Instituto Editoriale Medico, Via Calzolerie 1, Bologna, Italy, 1951.

This book includes 626 pages of text and 75 pages of literature. The author bases his work on fifty cases of scleroderma which he has had the opportunity of studying during a period of three years at the Medical Clinic of the Unisity of Bologna, Italy. Because of the frequency with which scleroderma was diagnosed at his institution, the author believes that scleroderma is not rare. The first 175 pages are devoted to a description of the disease and its manifestations in the skin, viscera, bones, the vascular system and muscles. The pathogenesis of scleroderma is discussed extensively from page 175 to 440. This discussion covers such possible pathogenic agents as infections, viruses, toxic, traumatic, vitaminic, nervous, vascular, allergic and hormonal disturbances.

The association of scleroderma with other diseases, such as acute and chronic rheumatism, chorea, hyperparathyroidism and soft tissue calcifications covers the next 100 pages. The remainder of the book is devoted to a discussion of the roentgenological changes caused by scleroderma in the hands and in the skull, to the histopathological appearance of the affected tissues, and to the effect of cortisone. A summary concludes the book.

This book probably includes all that is known today about scleroderma and it should be very valuable to all who are interested in this disease.

Cesare Gianturco, M.D.

Mécanismes de l'action biologique des radiations. Par M. Errera, Universitè libre de Bruxelles, et A. Herve, Universitè de Liège. (Centre National de Recherches sur la Croissance normale et pathologique.) Paper. Pp. 106. Éditions Desoer, 21, rue Sainte-Véronique, Liège, France; Masson & Cie., Editeurs, 120, boulevard Saint-Germain, Paris, France, 1951.

This is a small but excellent monograph appearing in the Medicine and Biology series under the editorship of Marcel Florkin. In the opening chapter the authors give a short presentation of the physical foundations of ionizing radiations and discuss the dependence of the number and distribution of ions formed in gases and liquids upon the quantity and quality of these radiations. They then proceed to study the mechanism of their biologic effects and propose to consider two main approaches to this study. In the first approach they consider the biochemical lesions produced by the radiation on the level of the cell. In the second approach they extend these observations to the study of general effects produced in the organism by a total or local irradiation. There are two main theories to explain the production of biological effects. One, the "hit theory," attempts to correlate biological with known physical effects of radiations and ascribes these effects to direct action of the physical effects. The other group of theories are based on the assumption that toxic products are formed by the radiations which in an indirect way produce biological changes. Lea, Timofeef-Ressovski and others hold that most radiobiological changes can be explained by the hit theory but many other scientists believe that most effects are produced indirectly by chemical products which are formed. On the basis of a thorough study the authors discuss the pros and cons of these theories. They analyze the effects of various types of radiations upon the chemical constituents of cells in vivo, studying notably the importance of conditioning factors such as the role of water and oxygen upon the reactions

produced. Special reference is paid to the direct and latent effects on proteins, enzymes and nucleic acids. Similar studies are then carried out in situ, where again special attention is paid to the effects of water, oxygen, the pH, cytochemical changes and differences in sensitivity. Here conditions become more complicated. Comparative studies between the toxic effects of radiation and mitotic poisons are described. The authors feel that, despite the large amount of experimental work carried out, the answer as to which theory can explain all the radiobiological phenomena cannot yet be given and that the whole question of the determination of the biochemical nature of lesions is still in its very beginning. Only advances in radiation chemistry and a better knowledge of cellular metabolism will bring further progress in this field.

Otto Glasser, Ph.D.

Law of Hospital, Physician, and Patient. By Emanuel Hayt, LL.B., Lecturer in Hospital Administration. Columbia University and University of Minnesota; Counsel Hospital Association of New York State, and The Greater New York Hospital Association; Lillian R. Hayt, M.A., J.D., of the New York Bar; and August H. Groeschel, A.B., M.D., M.S., Assistant Director, The New York Hospital; Colonel, Medical Corps, U. S. Army Reserve. Second edition, revised and enlarged. Prepared in Collaboration with the American College of Hospital Administrators. Cloth. Pp. 804. Hospital Textbook Company, 99 Wall Street, New York 5, New York, 1952.

Most matters of law are distasteful to the average physician, dentist, and hospital administrator, but contact with legal procedures is almost inevitable to them at some time during their careers. For that reason, some knowledge of the law as it applies to the hospital, the physician and the patient seems to be imperative. This book of seven parts and fifty-four chapters is a complete guide for all persons in the medical field in their contacts with the labyrinths of the law. The authors of this compact volume are a competent lecturer in hospital administration, an attorney, and a medical hospital director. They have covered the legal ramifications of every important phase of the care of the patient from their opening chapters on the nature and sources of law up to and including the most recent court decisions pertaining to the traditional immunity of charitable institutions from suit and to the latest enabling acts for the various state medical care insurance plans. The book is profusely documented and the list of citations for each chapter is impressive, clearly showing the tremendous task undertaken by the authors in their search through case reports for authoritative material for this second edition.

The seven chapters making up Part I, which deals with the law and its administrations, are a distinct innovation in medicolegal literature. These chapters furnish to those not familiar with legal proceedings and terminology an elementary course in the application of the law. Parts II, III, and IV are devoted to the legal aspects of hospital organization and administration. Parts V and VI are confined to the professional care of the patient. There is a chapter on each of the medical specialties including dentistry, and four chapters on medical records with a discussion of the legal viewpoint of their confidential nature. Part VII is made up of five chapters which discuss various contractual relationships and obligations as they apply to hospitals, physicians and insurance plans.

The book is printed in clear type on a good grade of paper and is well bound. It is easily readable and makes the law, which is ordinarily dull reading to the average physician, a live and interesting subject. This volume should be an excellent text for students in hospital administration, a ready reference book for physicians and hospital administrators, and it cannot be too highly recommended for inclusion in every hospital and law library. The chapter analysis, list of abbreviations of law reports, glossary, and index are adequate.

S. W. Donaldson, M.D.

BOOKS RECEIVED

The Normal Encephalogram. By Leo M. Davidoff, M.D., Director of Neurological Surgery, Beth Israel Hospital, New York City; Clinical Professor of Neurosurgery, New York University Postgraduate Medical School; and Cornelius G. Dyke, M.D., Late Associate Professor of Radiology in the College of Physicians and Surgeons, Columbia University; Late Director, in the Department of Radiology of the Neurological Institute of New York, New York City. Third edition, thoroughly revised by Leo M. Davidoff, M.D. Cloth. Price, $6.00. Pp. 240, with 156 illustrations. Lea &

Febiger, Washington Square, Philadelphia 6, Pennsylvania, 1951.

Vertebral Angiography by Catheterization. A New Method Employed in 221 Cases. Acta radiologica, Supplementum LXXXVII. By Stig Radner. Paper. Price, Swedish Crowns 20:-. Pp. 134, with 68 illustrations. Acta radiologica, Stockholm 2, Sweden, 1951.

Clinical Dental Roentgenology. Technic and Interpretation. Including Roentgen Studies of the Child and the Adolescent. By John Oppie McCall, D.D.S., F.A.C.D., Former Director, The Murry and Leonie Guggenheim Dental Clinic; etc.; and Samuel Stanley Wald, D.D.S., F.A.C.D., Clinical Professor of Oral Cancer and Roentgenology, New York University College of Dentistry, etc. Third edition. Cloth. Price, $8.50. Pp. 384, with 475 illustrations. W. B. Saunders Company, West Washington Square, Philadelphia, Pennsylvania, 1952.

Roentgen Examination of Pleural Fluid. A study of the localization of free effusions, the potentialities of diagnosing minimal quantities of fluid and its existence under physiological conditions. Acta radiologica, Supplementum 86. By Ingemar Hessén. Paper. Price, Swedish Crowns 20:-. Pp. 80, with 98 illustrations. Acta radiologica, Stockholm 2, Sweden, 151.

Le zone polmonari. Anatomia e morfogenesi. By G. Lambertini and D. Catalano. Paper. Pp. 134, with 60 illustrations. Libreria Scientifica Editrice, Corso Umberto 1, 40, Napoli, Italia, 1950.

Roentgen Examinations in Acute Abdominal Diseases. By J. Frimann-Dahl, M.D., Ph.D., Chief of Roentgen Department, Ullevål Hospital, Oslo, Norway. Cloth. Price, $10.50. Pp. 323, with 305 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1951.

Röntgendiagnostik des Herzens und der grossen Gefässe. Von Prof. Dr. Erich Zdansky, Vorstand des Zentral-Röntgeninstitutes am allgemeinen Krankenhaus in Wien. Zweite, erweiterte Auflage. Cloth. Price, $19.50. Pp. 434, with 294 illustrations. Springer-Verlag, Mölkerbastei 5, Wien, 1949.

Klinische Elektrokardiographie. Lehrbuch für Studierende und Ärzte. Von Dr. Max Holzmann, Zürich. 2., erweiterte und verbesserte Auflage. Cloth. Price, DM 69.60. Pp. 652, with 302 illustrations. Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1952.

Clinical Pediatric Urology. By Meredith Campbell, M.S., M.D., F.A.C.S., Professor of Urology, New York University Post-Graduate Medical School; Visiting Urologist, Bellevue and University Hospitals, New York. With a Section on Nephritis and Allied Diseases in Infancy and Childhood. By Elvira Goettsch, A.B., M.D., Associate Professor of Pediatrics, University of Southern California School of Medicine, and Assistant Medical Director of The Children's Hospital Society of Los Angeles; and John D. Lyttle, A.B., M.D., Late Professor of Pediatrics, University of Southern California School of Medicine, and Medical Director of The Children's Hospital Society of Los Angeles. Cloth. Price, $18.00. Pp. 1,113, with 543 illustrations. W. B. Saunders Company, West Washington Square, Philadelphia 5, Pennsylvania, 1951.

The Management of Fractures, Dislocations, and Sprains. By John Albert Key, B.S., M.D., St. Louis, Missouri, Clinical Professor of Orthopedic Surgery, Washington University School of Medicine, etc.; and H. Earle Conwell, M.D., F.A.C.S., Birmingham, Alabama, Associate Professor of Orthopaedic Surgery, University of Alabama School of Medicine, etc. Fifth edition. Cloth. Price, $16.00. Pp. 1,232, with 1,195 illustrations. C. V. Mosby Company, 3207 Washington Boulevard, St. Louis 3, Missouri, 1951.

Post-Graduate Lectures on Orthopedic Diagnosis and Indications. By Arthur Steindler, M.D., F.A.C.S., Professor of Orthopedic Surgery, State University of Iowa, Iowa City, Iowa. Volume III. Section A: Tuberculosis of the Skeletal System. Section B: Osteomyelitis. Cloth. Price, $8.75. Pp. 284, with 255 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1952.

A Handbook of Diseases of the Skin. By Herbert O. Mackey, F.R.C.S.I., L.R.C.P.I., D.P.H. (Univ. Dub.), L.M., F.R.I.A.M., Fellow of St. John's Dermatological Society, London; Member of the Dermatological Section of the Royal Academy of Medicine, Dublin; etc. Cloth. Price, 7/6 net. Pp. 216, with 36 illustrations. C. J. Fallon, Limited, 9[B] Lower Abbey Street, Dublin, Ireland, 1952.

Tumeurs malignes de la vessie. Traitement par la radiumthérapie à vessie ouverte. Par Raymond Darget, Professeur de Clinique Urologique à la Faculté de Médecine de Bordeaux. Paper. Price, 1200 Fr. Pp. 105, with 83 illustrations and 1 color plate. Masson et Cie., 120, boulevard Saint-Germain, Paris, France, 1951.

Grundlagen der therapeutischen Strahlenwirkung. Von Dr. Hermann Holthusen. Paper.

Pp. 34. Conrad Kloss, Bergstrasse 26, Hamburg 1, Germany, 1951.

Queensland Radium Institute. Sixth Annual Report to the Honourable the Minister for Health and Home Affairs. For the Year Ended 30th June, 1950. Presented to Parliament and Ordered to be Printed. A. H. Tucker, Government Printer, Brisbane, Queensland.

Indications for and Results of Splenectomy. By Frederick A. Coller, M.D., Alexander Blain, III, M.D., and Gould Andrews, M.D. From the Departments of Surgery and Medicine, University of Michigan Medical School, Ann Arbor, Michigan. Fabrikoid. Pp. 100, with 16 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1950.

Mécanismes de l'action biologique des radiations. Par M. Errera, Université libre de Bruxelles, et A. Herve, Université de Liège. (Centre National de Recherches sur la Croissance normale et pathologique.) Paper. Pp. 106. Éditions Desoer, 21, rue Sainte-Véronique, Liège, France; Masson & Cie., Editeurs, 120, boulevard Saint-Germain, Paris, France, 1951.

Industrial Medicine on the Plutonium Project. Survey and Collected Papers. Edited by Robert S. Stone, M.D., Professor of Radiology and Chairman of the Division of Radiology, University of California School of Medicine; formerly Associate Project Director for Health, Metallurgical Project, University of Chicago; Consultant, Argonne National Laboratory. First edition. Cloth. Pp. 511, with numerous illustrations and tables. McGraw-Hill Book Company, 330 West 42nd Street, New York 18, New York, 1951.

Tenth Semiannual Report of the Atomic Energy Commission. United States Atomic Energy Commission. Paper. Pp. 151. United States Government Printing Office, Washington, D. C., July, 1951.

The Treasury of Human Inheritance. Edited by L. S. Penrose, M.D., Galton Laboratory, University College, London. Volume V. On Hereditary Digital Anomalites. Part I. On Brachydactyly and Symphalangism. By Julia Bell, M.A., F.R.C.P. Paper. Price, $3.00. Pp. 31, with numerous illustrations. Cambridge University Press, American Branch, 32 East 57th Street, New York 22, New York, 1951.

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Neck and Chest

Wilson, Edric. Mediastinal goitre. *Brit. J. Surg.*, Sept., 1951, *39*, 120–125.

Anterior mediastinal goiter is rather common in areas where goiter is endemic. Less frequent is the posterior mediastinal goiter which lies against the vertebral column, pressing the esophagus laterally forward and the trachea forward. The pedicle attaching it to the thyroid in the neck may be small. The important structures such as the recurrent laryngeal nerve, inferior thyroid artery and great vessels lie in front of the mass. Many cases are asymptomatic and are found accidentally in mass survey of the chest.—*Joseph Levitin, M.D.*

Beilin, David S., Fink, Jack P., and Leslie, Lawrence W. Correlation of postmortem pathological observations with chest roentgenograms. *Radiology*, Sept., 1951, *57*, 361–372.

This paper is a correlation between the clinical features, the postmortem pathologic findings, and the roentgen findings in pulmonary congestion, edema, embolism, infarction, pneumonia and atelectasis. Roentgenograms were taken postmortem with the body supported in the upright position.

Pulmonary Congestion and Edema. Most common causes are: (1) left ventricular failure secondary to arterial hypertension; (2) coronary artery disease and myocardial infarction; (3) aortic and mitral valve disease. Massive pulmonary engorgement occurs when there is insufficiency of the left heart and an adequate output of the right heart. Simple engorgement of the blood vessels results in an accentuation of the hilar shadows and the adjacent lung markings on the roentgenogram. In chronic passive congestion there are, in addition, numerous minor shadows. Acute pulmonary edema manifests itself by a cloudiness of the central portions of the lungs, in a fan-like or butterfly pattern. Apices, periphery, and bases of the lungs are relatively clear.

Pulmonary Embolism and Infarction. Infarcts occur almost exclusively in connection with stasis of the pulmonary circulation from cardiac insufficiency. Massive occlusion of a main branch of the pulmonary artery by an embolus usually causes instant death. Occlusion of a smaller artery will probably result in infarction if sufficient time elapses.

Infarcts frequently exhibit roentgenologically a slight increase in density at the base of the lung field, with blurring or obscuring of a portion of the diaphragm shadow. Elevation of the diaphragm and pleural effusion, obscuring the infarction, are not uncommon. Infarcts may be visualized from twelve to twenty-four hours after embolism occurs. Appearance often resembles that of bronchopneumonia. In this survey no case of pulmonary embolism was diagnosed roentgenologically by Westermark's criteria.

Pneumonia. Roentgenologically a patchy or lobular pneumonitis is the most common finding, usually involving the lower lobes and almost always extending out to the periphery. As a rule, the disease is bilateral. Attention is called to the not infrequent association of bronchogenic carcinoma or an adenoma of the bronchus with a lobar pneumonic process.

Atelectasis. Classical signs of obstructive atelectasis are: (1) decrease in size of the involved hemithorax; (2) shift of the trachea and other mediastinal structures toward the involved side; (3) elevation of the diaphragm with dullness to percussion; (4) absence of breath sounds over the involved lobe.

Roentgenologically, the heart and mediastinal contents are shifted to the affected side and the diaphragm is elevated when a whole lobe is involved, particularly a lower lobe. Upper lobe collapse usually results in a shift of the trachea. In the absence of displacement of the mediastinum, the appearance and position of the septa and hilus of the lung may be the first signs suggesting the diagnosis.—*A. W. Sommer, M.D.*

Yerushalmy, J., Garland, L. H., Harkness, J. T., Hinshaw, H. C., Miller, E. R., Shipman, S. J., and Zwerling, H. B. An evaluation of the role of serial chest roentgenograms in estimating the progress of disease in patients with pulmonary tuberculosis. *Am. Rev. Tuberc.*, Sept., 1951, *64*, 225–248.

A study designed to evaluate the reliability of interpretation of single posteroanterior roentgenograms of the chest obtained three months apart was undertaken by three phthisiologists and three radiologists. The need for such an objective study is apparent in view of the tacit reliance on film interpretations by clinicians, oftentimes without other diagnostic tests.

The study was based on examination of 150 pairs of 14 by 17 inch roentgenograms of representative cases of pulmonary tuberculosis. These included 47 pairs of roentgenograms of patients receiving streptomycin in the reading interval; 60 pairs from a predominantly chronic disease sanatorium group; 27 pairs from a county hospital group; and 16 pairs from a private sanatorium group.

The roentgenograms were interpreted individually by the six physicians. After a lapse of some time and without knowledge of the results of the first interpretation, they were re-interpreted by the same readers. Judgment was expressed in three ways: first, based on the entire lung field and then, separately, for changes in the right lung and the left lung. Classification was made according to direction of change, utilizing the three simple categories *better*, *no change*, and *worse*.

In assessing the percentage of disagreement, for

each pair of roentgenograms four comparisons for each pair of readers were available. Since there are 15 ways of pairing the six readers against each other, a total of 60 comparisons was available for every pair of roentgenograms. Thus, for the entire group of 150 pairs of roentgenograms there was available a total of 60 multiplied by 150, or 9,000 comparisons.

Observing certain criteria and judging poor technique films as a group apart, there were 8,931 useable comparative interpretations of the entire lung fields. There were 6,245 instances in which the same symbols were used by two readers and 2,686 in which there was disagreement. There was, therefore, a 30.1 per cent disagreement between readers. Reader's inconsistency with himself based on 893 comparisons amounted to 21.5 per cent.

There were small percentage differences in interpretation of roentgenograms in the following instances: poor technique; between radiologist who read 41 films as improved, 71 no changes and the phthisiologist who read 61 films as improved, 50 no changes; in the streptomycin group where no category could be agreed upon in 11 cases. The sanatorium chronic group offered 32.3 per cent inter-individual and 24.8 per cent intra-individual disagreement.

The study indicates that in judging a pair of roentgenograms for regression or stability of the tuberculosis, based on study of the entire lung field, two readers will disagree with each other in nearly one-third of the cases and a single reader is likely to disagree with himself in approximately one-fifth of the cases.—*E. E. Julien, M.D.*

Zwerling, Henry B., Miller, Earl R., Harkness, James T., and Yerushalmy, J. The clinical importance of lesions undetected in a mass radiographic survey of the chest. *Am. Rev. Tuberc.*, Sept., 1951, *64*, 249–255.

In an effort to answer the question, "Do mass surveys discover all active cases of pulmonary tuberculosis?" the authors have made a critical sutdy of 1,807 photofluorograms of entering college students. The films were interpreted individually by six readers.

On 254 films, abnormal shadows were found and subsequently 14 by 17 inch roentgenograms made for confirmation. By this procedure, 30 persons were identified as "roentgenographically positive," requiring further clinical study. Seven of the 30 were proved to have clinically active tuberculosis.

There were in all, 300 readings on the "roentgenographically positive" cases. Positive readings were made in 205 instances and negative readings in 95 instances. This indicates that the positive findings were overlooked in 31.7 per cent of the interpretations. In the 7 active cases, 37.1 per cent of the interpretations overlooked the lesions.—*E. E. Julien, M.D.*

Abdomen

Bauer, R. Röntgenschichtuntersuchungen der Gallenblase und -wege (vorläufige Mitteilung). (Laminagraphic studies of the gallbladder and its pathways; preliminary report.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Aug., 1951, *75*, 159–165.

The author performed laminagraphy of the gallbladder after the administration of oral contrast material and believes that he has added to the diagnostic possibilities by the use of this method. For example, gallstones could be demonstrated, which otherwise might be confused with bowel contents, calcified mesenteric lymph nodes and calcification of the cartilage of the ribs. These findings were manifest in cases where routine cholecystography failed to show any abnormality. Also, deformity of the gallbladder by the presence of septa or through pericholecystic adhesions could be shown clearly. In addition, laminagraphy revealed whether or not the gallbladder visualized faintly after the contrast material had been given and whether or not a pathological gallbladder could be demonstrated prior to the administration of the contrast material. The exposures were made with the patient prone, by sectioning in layers of 0.5 cm. at a depth of from 2.0 to 4.5 cm.

Several interesting cases are illustrated with excellent reproductions.—*Samuel Richman, M.D.*

Mixter, Charles G., Hermanson, Louis, and Segel, Arnold L. Operative cholangiography; an evaluation of 406 cases. *Ann. Surg.*, Sept., 1951, *134*, 346–350.

Clinical indications for exploration of the common duct are so inaccurate that 50 per cent of such explorations are found to be unnecessary. Choledochostomy has definite risks and is not to be undertaken lightly.

In a series of 406 cases on which operative cholangiography was performed, negative explorations were reduced materially. It was also found that the safety of biliary tract surgery was increased and the necessity for secondary operations on the common duct was reduced by demonstrating overlooked common duct stones at the first operation.

The technique is described in detail.—*L. A. Davis, M.D.*

Zaccone, Giovanni. Colecistite acuta gassosa. (Acute gaseous cholecystitis.) *Radiol. med.*, Aug., 1951, *37*, 622–634.

The author reports in detail a case of acute gaseous cholecystitis which was first observed on a cholecystogram and then studied as to its relationship with the neighboring organs by means of an opaque meal and

barium enema. Two months later the patient, following a violent attack of pain, passed an oval stone measuring 2 by 4 cm. in diameter. Re-examination by means of barium meal revealed the presence of an internal biliary fistula, indicating that the stone had perforated from the gallbladder into the duodenum. The gas had completely disappeared. One year later the patient enjoyed good health.

Gas may be present in the gallbladder (1) as a result of a fistulous tract with the digestive tube, (2) by passing from the duodenum through an incontinent sphincter of Oddi and (3) due to local formation in case of infection by the gas bacillus. On the basis of the findings of the examinations performed, the author believes that the case described by him can be placed in the third category.

In conjunction with this case, the author has also made an exhaustive review of the world medical literature and found that only 26 cases of gaseous cholecystitis were reported between 1908 and 1949. All of these cases are listed individually with a brief summary of the pertinent data in each case.—*T. Leucutia, M.D.*

New, Paul F. J. Prolapse of the prepyloric mucosa. *Brit. J. Radiol.*, Aug., 1951, *24*, 441–453.

The incidence of this condition is difficult to estimate, as the diagnosis is being made with increasing frequency. It is probably seen about as frequently as gastric ulcer. The age range is quite wide, from sixteen to seventy-four years in 50 cases examined by the author. The condition occurs three times as often in males as in females.

The etiology is not fully understood. Some authors consider it a result of inflammatory changes in the antral mucosa, while others feel that prolapse may be observed without pre-existing gastritis and may occur in either a normal stomach or one in which there is mucosal edema from some systemic cause.

Because of the varied and nonspecific symptoms, clinical recognition is usually impossible. The diagnosis is essentially roentgenological. In uncomplicated cases there are frequently epigastric pain, heartburn, feeling of distention, eructation, occasional vomiting, and a variable response to alkalis. Serious symptoms are those of obstruction or massive hemorrhage, although slight bleeding occurs more often. It is common to have remissions. Gastroscopy and gastric analysis are not usually helpful in diagnosis.

The essential finding is an irregular space occupying defect in the base of the duodenal bulb. It has been described as resembling a mushroom, an umbrella, or cauliflower. It may change in appearance from examination to examination and may change during a single examination. It may be seen with the patient upright or horizontal. In many cases, large, irregular and hypermobile prepyloric folds are observed; antral gastritis or more frequently antral narrowing may occur. A six hour gastric residue may or may not be present. Associated lesions of the stomach and duodenum are common and should be looked for.

Among the conditions which might occasionally be difficult to differentiate from prolapsed mucosa are the following: aberrant gastric fold, in which the deformity is constant and regular; duodenal or pyloric ulcer; benign duodenal or gastric neoplasms; duodenitis; antral carcinoma; adult hypertrophic pyloric stenosis, which is usually quite smooth, and in which the canal is elongated; and antral gastritis and spasm.

Conservative treatment is usually indicated. Surgical intervention is necessary for obstruction, continued bleeding, or for investigation of those cases where it is not possible to exclude neoplasm. The usual operation is simple antral incision, resection of the prolapsed or redundant mucosa, and some type of pyloroplasty. In most cases it is necessary to open the antrum to confirm the diagnosis at the operation.—*E. F. Lang, M.D.*

Diaz, J. R. Casanova. Carcinoma of the stomach; report of an epidermoid carcinoma of the pyloric antrum. *Surgery*, Sept., 1951, *30*, 554–559.

The author refers to a recent review of the literature on epidermoid carcinoma of the stomach in which 9 such lesions were found. He adds another such case, the neoplasm being located in the pyloric antrum. He discusses the possible origin of such a tumor. A recent theory is that of Duran-Jorda, who states that the tumor arises from a flat epithelial layer which overlies all mucous membrane surfaces. This layer is said to be very fragile, and can be destroyed by formol-saline fixation or postmortem changes. It can be seen in the human fetus. It is contended that the discovery of this epithelial layer does away with such tenuous explanations as metaplasia.—*André Bruwer, M.D.*

Imbriglia, Joseph E., Stein, George N., and Lopusniak, Mieczyslaw S. Cytological study of the upper gastrointestinal sediment; its value, as correlated with roentgenologic and clinical findings, in the diagnosis of cancer. *J.A.M.A.*, Sept. 8, 1951, *147*, 120–122.

This is a report of results of cytological examination of sediment obtained from the upper gastrointestinal tract of more than 100 patients at Graduate Hospital at the University of Pennsylvania. The data obtained by the procedure in the diagnosis of cancer was compared with the roentgen interpretations and correlated with the clinical, surgical or autopsy findings.

The technique is described and emphasis is placed

on care in following it closely. It was found that the roentgenologic and cytological methods were equally accurate in diagnosis of cancerous lesions, regardless of their location in the esophagus or stomach. It is felt that too much reliance should not be placed on a negative or noncancerous report. False negative findings may result: (1) if sediment is improperly obtained from a retentive stomach, (2) if the lesion does not involve the mucosa, and (3) if an ulcerating cancer has become secondarily infected.

It is felt that, despite the known difficulties associated with the procedure, cytological examination should be employed in all cases of suspected cancer, as a procedure complementary to roentgenography and endoscopy.—*R. D. Moreton, M.D.*

Kronen, W. Die anatomische Qualitätsdiagnose im unteren Magenabschnitt und im bulbus duodeni auf Grund der Röntgenuntersuchung. (Qualitative anatomical diagnosis in the distal portion of the stomach and duodenal bulb on the basis of roentgen examination.) *München. med. Wchnschr.*, Sept. 28, 1951, *93*, 1930–1935.

The author has found a new drug, oktinum-D, to be a valuable adjunct in the roentgen examination of the stomach and duodenum. It is a nonalkaloid, hydrochloride of isoamylamino-6-methyl-2-heptan, which has a papaverinelike action as well as an antiparasympathetic effect. Studies were made one-half hour after the intramuscular injection of 0.15 cc. or 75 mg. of oktinum-D.

The duodenal bulb is satisfastorily unfolded so that it is easier to differentiate organic from spastic changes. The pyloric canal is more clearly defined and opens even in the presence of a duodenal or pyloric ulcer. Relaxation of the prepyloric region permits differentiation between callous ulcers and small tumors; also, a better roentgen kymographic study of the peristaltic action in this portion of the stomach is obtained. Demonstration of passive motility of the dependent portion of the stomach provides a good indication of operability.—*Joseph Zausner, M.D.*

Newell, Robert B., Rosenbaum, George R., and Canter, Noland M., Jr. Traumatic retroperitoneal rupture of the duodenum. *Ann. Surg.*, Aug., 1951, *134*, 277–278.

This is a case report of a twenty year old soldier who incurred a retroperitoneal rupture of the duodenum when a vehicle he was driving struck an abutment. The diagnosis was suspected clinically and confirmed roentgenographically when free air was demonstrated retroperitoneally, most marked about the right kidney and psoas shadows. No free air was noted under the domes of the diaphragm.

Successful surgical closure was made.—*F. B. Markunas, M.D.*

Orr, I. M., and Russell, J. Y. W. Diverticulosis of the jejunum—a clinical entity. *Brit. J. Surg.*, Sept. 1951, *39*, 139–147.

Patients with diverticulosis of the small intestine may be divided into three groups: (1) those who exhibit no symptoms at all, (2) those who have mild chronic indigestion and (3) those who suffer from an acute abdominal catastrophe due to a complication arising in one or a group of diverticula.

The major complications described are:

a. Acute diverticulitis resulting in: (i) perforation with generalized peritonitis or abscess formation, (ii) adhesions or stricture which may produce intestinal obstruction, torsion, or volvulus and (iii) cyst formation.

b. Hemorrhage.

c. Concretion formation.

d. Traumatic rupture.

e. Foreign body impaction.

f. Infestation with intestinal parasites.

The authors feel that any patient suffering from vague dyspepsia, in whom the commoner forms of gastrointestinal pathology have been excluded, should be examined with the possibility of diverticulosis being demonstrated. To see the barium filling a jejunal pouch, the meal should be followed at half hour intervals. If a diverticulum is demonstrated and palpation reveals tenderness, the evidence is strongly in favor of the diverticulum being the cause of the patient's symptoms.

The case histories of 13 patients with jejunal diverticula are reviewed. In 3 cases patients exhibited no symptoms, 4 had mild dyspepsia, and 6 had acute complications. Of the latter, 4 exhibited hemorrhage and 2 acute abdominal inflammation due to diverticulitis.

The authors would suggest in conclusion that diverticulosis of the jejunum is by no means a rarity, that it may give rise to acute abdominal symptoms, that it may be the cause of hematemesis or melena, or may be the cause of chronic vague dyspepsia. When other pathology can be excluded, diverticulectomy or resection of the affected segment of jejunum may be expected to afford relief.—*W. C. McCarty, Jr., M.D.*

Zeluff, George W., and Parsonnet, Victor. Ruptured aneurysm of the splenic artery: case report with discussion. *Ann. Int. Med.*, Aug., 1951, *35*, 437–443.

The authors report a case of ruptured aneurysm of the splenic artery in a female thirty-two years of age with an initial diagnosis of pleural effusion. Thoracocentesis of the left chest yielded about a quart of brown fluid. Malaise, swelling of the abdomen and inconstant low back pain were noted by the patient.

Physical examination revealed a massive pleural effusion, distended, tympanitic abdomen, with

questionable signs of fluid, and a firm, tender mass in the left upper quadrant. Besides the pleural effusion, roentgenograms revealed irregular calcified nodules believed to be in the pancreas and displacement of the stomach forward and to the right.

At the second admission, the patient complained of dyspnea and severe pain in the left chest. She died suddenly 100 days after the onset of her illness.

At necropsy the left pleural and peritoneal cavities were filled with fresh and old clotted blood. One centimeter from the origin of the splenic artery and extending 2.5 cm. along it was a saccular aneurysm. The aneurysmal sac measured 10 cm. in diameter and showed many outpouches arising from it. One of these had extended through the left diaphragm and had ruptured into the left pleural cavity.

The main factors believed responsible for the formation of aneurysms of the splenic artery are arteriosclerosis, septic emboli and congenital anomalies. Trauma, "wandering spleen," Gaucher's disease, Banti's disease, syphilis and medial necrosis have also been mentioned as possible causes. Rarely, steatorrhea, pancreatic calculi and pulsating filling defects of the stomach may be observed in these cases.

The ideal procedure in therapy is complete removal of the aneurysmal sac and spleen, preferably prior to rupture if the diagnosis is made.—*J. N. Ané, M.D.*

Arnheim, E. E. Retroperitoneal teratomas in infancy and childhood. *Pediatrics*, Sept., 1951, *8*, 309–327.

The two most common retroperitoneal tumors of infancy and childhood are the neuroblastoma sympatheticum and the renal embryoma. Teratomas are third in order of frequency. Thirty-nine cases of retroperitoneal teratomas, histologically verified, have been reported in the literature. The author has observed 3 additional cases in the Boston Children's Hospital and has treated 2.

A teratoma is a tumor containing multiple tissues of parts foreign to the structure in which it arises. It displays progressive uncoordinated growth. All of these tumors of the extraperitoneal intra-abdominal group are in the vicinity of the primitive mesentery. These tumors contain representatives of the three embryonal elements—ectoderm, entoderm, and mesoderm. The more benign teratomas consist of mature tissue with no evidence of proliferation. The malignant tumors contain immature embryonic tissue. Teratomas may be predominantly cystic or solid. Retroperitoneal teratomas are usually cystic and arise high in the retroperitoneal space.

The most common clinical findings are abdominal enlargement and a palpable mass. Abdominal pain is not common. Still less common complaints are fever, vomiting, weight loss and constipation.

Roentgen studies, made in 12 of the 39 reported cases, revealed areas of ossification in the tumor. In 9 cases retrograde pyelography showed displacement of the kidney or ureter.

Operative removal is the only method of treatment recommended.

The author tabulates the 39 previously reported cases and describes in detail the 3 cases which he has personally observed. Two of the 3 were benign and survived, the third was malignant and died. No cure of malignant teratoma of the retroperitoneal structures has been reported.—*R. M. Harvey, M.D.*

Gerlach, Bernhard. Ein Schnellverfahren zur Röntgendarstellung des Wurmfortsatzes. (A rapid procedure for roentgen visualization of the appendix.) *Deutsche med. Wchnschr.*, Sept. 28, 1951, *76*, 1206–1207.

The author first comments upon the time-consuming and uncertain routine procedures for visualization of the appendix (oral barium or barium enema). He then describes his own method which is similar to one used by others for rapid small bowel studies. This method is as follows: Gastric fluoroscopy is done with 8 ounces of "Neobar" in 250 cc. of physiological saline solution, followed by 250 cc. of ice-cold saline solution and, five minutes later, by another 250 cc. of ice-cold saline solution. Two hours later, breakfast or a hot meal is given. A roentgenogram is taken four hours after the cold drink. At this time, cecum, ascending colon, transverse colon and appendix are usually well filled. Stomach and small bowel are empty except for residual barium in the terminal ileum.

Examination of 40 healthy persons showed filling of the appendix in 34 cases and re-examination of the remaining 6 showed filling in 4 cases. In 2 cases, the appendix again remained unfilled.—*E. G. Wissing, M.D.*

Cantor, Meyer O. Swallowed intestinal decompression tubes. *Am. J. Digest. Dis.*, Aug., 1951, *18*, 250–254.

With the widespread use of intestinal decompression tubes as an effective means in the treatment of intestinal obstruction, accidents and errors are bound to occur.

Swallowing of the entire tube is not uncommon. It has been considered dangerous, but is usually harmless. The causes of swallowing intestinal tubes may be:

1. Deliberate, on the part of the patient, probably as a mental aberration in the form of self-torture.
2. Because intern or nurse instructed patient to do so, so as to remove the tube.
3. Because it is difficult or impossible to remove the tube from above due to:
   a. Persistent spasm of a sphincter in an apprehensive patient.

b. Permeation of intestinal gases into the balloon of the tube, which becomes large and difficult to remove, especially the Harris tube which is 6 inches long and may hold as much as 125 cc. of gas.
c. Air-filled balloon may act like a space-consuming tumor producing intussusception of the bowel.

4. Due to forceful peristaltic activity, an intestinal decompression tube that is not fastened to the face may emerge from the anus. In these cases, the tube may be cut at the nose and permitted to pass.

In the vast majority of cases, the tube will be passed by rectum. Transit time varies from four hours to twenty-nine days. Patience on the part of the physician, as well as reassurance of the patient, is all that is necessary.

Arrest of the tube in the gastrointestinal tract is presumptive evidence of partial obstruction distal to the tube. Surgical correction of the partial obstruction will permit the tube to pass. Often, bands of adhesions or kinking are responsible. These may be severed without opening the bowel. If the balloon is distended, it may be broken by manual compression and removed through a minimal enterotomy. Intussusception, due to an air-filled balloon, is a positive indication for immediate surgery.

Case reports, with reproductions of roentgenograms, are presented to illustrate swallowed intestinal decompression tubes due to the various causes listed above.

The report is based on observations on 5,000 intubations at Grace Hospital in Detroit.—*W. H. Shehadi, M.D.*

Schorr, S., Ullmann, T. D., and Laufer, S. Pneumatosis cystoides intestinalis. *Arch. Int. Med.*, Sept., 1951, *88*, 362–372.

Pneumatosis cystoides intestinalis has been infrequently diagnosed preoperatively. However, in the future this situation should be reversed, as the roentgenographic findings are quite characteristic. A historical review is presented, indicating that the first description of this condition was printed in 1747.

There is no clear-cut clinical picture indicating the presence of multiple gaseous cysts within the walls of the digestive tract, and most of the patients' complaints seem unrelated to this condition. It seems, however, that in a large majority of the reported cases the underlying condition presenting symptoms was a stenosing lesion, usually an ulcer in the pyloric region of the stomach, and occasionally an obstruction at a lower point along the gastrointestinal tract, due to adhesions, volvulus, or similar conditions. The coincidence of stenosing lesions and gas cysts is frequent enough to point to a possible causal relationship between them. On the other hand, the gas cysts themselves may narrow the lumen of the intestine to an appreciable degree, and thus bring about a partial or complete obstruction with its clinical manifestations. In many cases, superficial gas cysts rupture and air accumulates in the peritoneal cavity. The pneumoperitoneum does not cause symptoms or clinical signs unless present in large amounts.

The roentgenographic findings include the foam-like appearance of the gas cysts themselves, the pressure defects in the barium-filled small intestine caused by the small submucosal air cysts; pneumoperitoneum caused by the rupture of large air cysts, and in a fair number of cases the presence of loops of small intestine between the liver and the diaphragm has been observed.

The etiology and mechanism of the cyst formation are not definitely known. Certain possible etiologic factors are discussed. A case report is presented of a patient under observation for four years, in whom the diagnosis was made roentgenographically, and with follow-up autopsy findings.—*D. S. Kellogg, M.D.*

Olson, John D., Dockerty, Malcolm B., and Gray, Howard K. Benign tumors of the small bowel. *Ann. Surg.*, Aug., 1951, *134*, 195–204.

This article is a review of the records and the tissue from 77 cases of benign tumors of the small bowel seen at the Mayo Clinic.

The clinical review indicated that there is no symptom pathognomonic of small bowel tumors.

Ten different types of neoplasms were found. These were: adenomas, leiomyomas, fibromas, lipomas, accessory pancreatic rests, hemangiomas and cysts. In addition, one case each of lymphangioma, hematoma, and osteochondroma was found.

The three main types of clinical symptoms encountered were bleeding, symptoms of obstruction, and those referable to local irritation produced by the tumor.—*J. H. Harris, M.D.*

Cross, Frederick S. A new method for obtaining barium enemas in colostomy patients. *Surgery*, Sept., 1951, *30*, 460–464.

A method of employing barium enemas when patients have colonic stomas, and which avoids certain drawbacks of other methods, is described. This technique prevents seepage of barium around the catheter and gives the patient improved control over evacuation of the enema from the catheter. The equipment consists of a Rutzen type ileostomy bag, a No. 22 Bardex catheter fitted with a stopper, several other stoppers, a 50 cc. syringe and a hemostat. The hole in the face plate of the ileostomy bag is enlarged to about 2.5 cm. in order to fit over the colonic stoma. Directly opposite this hole, another hole, 1.5 cm. in diameter, is cut and stoppered with a No. 6 black rubber stopper. In this stopper is a hole

large enough to receive the stopper which is fitted on the Bardex catheter about 12 cm. from the tip. The ileostomy bag is applied with skin cement and the catheter traverses the bag and projects into the stoma. The Bardex balloon is inflated to a maximum of 15 cc. of air, which is not enough to stretch the bowel but is large enough to be anchored by the 2.5 cm. hole in the face plate of the ileostomy bag. After the enema has been administered, the catheter is clamped and the patient is taken to the bathroom where the Bardex balloon is deflated, the catheter removed and the hole for the catheter plugged with another stopper. The enema is then evacuated into the ileostomy bag and any subsequent barium which leaks from the colon during the process of making postevacuation films is retained in the ileostomy bag. —*P. G. Dillard, M.D.*

Storey, C. F., and Sharp, R. W. Congenital microcolon. *Am. J. Dis. Child.*, Sept., 1951, *82*, 345–356.

In the patient reported in this paper, there was an abnormally small colon from cecum to rectum. The authors have chosen the term microcolon as they believe it describes most accurately the condition which was present. All coats of the bowel were present in all areas and a lumen was found throughout, even though it was of microscopic size and was completely occluded. The patient was a newborn girl infant who was operated upon and died eight hours after operation.

The incidence of the condition, etiology, diagnosis, differential diagnosis and treatment are discussed in detail. The authors mention the theory of Greig who concluded that the fault causing the condition was an achalasia, a want of relaxation, due to a defect in the autonomic nervous system. Other theories are (1) the Bland-Sutton theory which holds that intestinal occlusions occur at the site of embryological events; (2) the vascular defects theory of Jaboulay and Wyss, which suggests that many intestinal occlusions result from defects in vascular supply of the intestine; (3) the theory of Tandler and Krueter, who found that the original lumen of the intestinal canal of most vertebrates is lost in the early part of embryonic life by epithelial proliferation, but is later reestablished, and who assume that in congenital intestinal occlusions recanalization has not occurred; (4) the theory that proposes intrauterine inflammatory reactions as a possible cause of these anomalies, and (5) the theory that defective internal rotation might be the basis for these defects. The authors quote the theories mentioned by Greig: (1) absence of vis à tergo; (2) occlusion of bowel lumen; (3) meconium ileus; (4) congenital patency of the ileocecal valve; (5) insufficient blood supply; and (6) defective nerve mechanism.

The striking similarity between the symptomatology, roentgenographic picture, clinical course, and operative findings in infants with congenital microcolon and meconium ileus is commented upon in the paper. They are clinically indistinguishable and the authors state they know of no way whereby a positive differentiation can be made even at operation. From a review of the literature, the authors assume that the really startling reduction of the caliber of the large bowel (to 3 to 4 mm. in their case, with no grossly demonstrable lumen) seen in congenital microcolon would not be encountered in meconium ileus. In addition, at autopsy no gross nor microscopical pathological change could be found in the pancreas.

The administration of barium to infants with microcolon is considered likely to be dangerous and is condemned by many writers. If, for any reason, it is given a thin mixture should be used, and as much of the barium as possible should be removed by aspiration. A study of the distended loops of bowel on the plain roentgenogram reveals adequate information and the use of barium by mouth is neither indicated nor advisable. A barium enema adds to the great discomfort and distress of the already distended infants, and even if an obstruction in the colon were demonstrated, it would not alter the operative exposure in any way.

Early diagnosis and prompt, adequate surgical therapy, the authors believe, will lead to a gratifying percentage of successes in the management of congenital intestinal occlusion in infants.—*R. S. Bromer, M.D.*

Brooke, B. N. and Cooke, W. T. Ulcerative colitis; a diagnostic problem and a therapeutic warning. *Lancet*, Sept. 15, 1951, *2*, 462–464.

The authors point out that although surgical treatment of the common type of ulcerative colitis is probably indicated, the postoperative course of those patients having involvement of the ileocecal valve is unsatisfactory. They believe that so-called ulcerative colitis involving the cecum and the terminal ileum is a different disease from that in the left side of the colon and should be considered to be more like regional enteritis (Crohn's disease). They feel that the finding of ulcerative colitis with ileal involvement contraindicates colectomy. Patients having ileocecal disease should of course be studied by barium enema and also by means of ingested barium.

Vagal section may be useful in therapy.—*C. L. Hinkel, M.D.*

Jackman, Raymond J., and Mayo, Charles W. The adenoma-carcinoma sequence in cancer of the colon. *Surg., Gynec. & Obst.*, Sept., 1951, *93*, 327–330.

The authors believe that sigmoidoscopic examination should precede roentgenologic examination of the large bowel for the following reasons:

1. The sites of about 70 per cent of both malignant and inflammatory processes are within reach of the sigmoidoscope.

2. It requires less technical knowledge to perform sigmoidoscopy and interpret the findings than it does to make and interpret a roentgenogram of the large bowel.

3. Barium given by mouth or as an enema to study the large bowel can be dangerous in that it may convert partial obstruction to complete obstruction.

4. Preparation of the patient with enemas for sigmoidoscopy is certainly less arduous than the castor oil purgation, fasting, and use of enemas needed for roentgen examination.

Summary and Conclusions. The concept of adenoma-carcinoma sequence in carcinoma of the large bowel is supported by (1) the close parallelism between the location of polyps and the location of carcinoma in various segments of the colon, (2) the close parallelism in age and sex incidence, (3) the frequency with which polyps are associated with carcinoma (the "sentinel" polyp), (4) the frequency of malignant degeneration in familial multiple polyposis, (5) subsequent replacement of known solitary adenomas by frank carcinoma, and (6) polypoidosis-carcinoma complications of chronic ulcerative colitis.

About 70 per cent of all carcinomas and polyps of the large bowel occur within reach of the sigmoidoscope.

Many adults in the age group of thirty to seventy years (variously estimated at from 7 to 17 per cent) have polyps and in a few instances early carcinomas of the large intestine which are entirely asymptomatic.

The relatively simple diagnostic maneuver of a sigmoidoscopic examination and the simplicity of destroying these precancerous adenomas would certainly warrant that physicians become more conversant with the procedure mentioned.

A sigmoidoscopic examination should practically always precede a roentgen examination of the large bowel, and it certainly should not be omitted just because the roentgenogram shows a lesion out of range of the sigmoidoscope.—*Mary Frances Vastine, M.D.*

Berger, Knute E., and Lundberg, Einar A. Intestinal volvulus precipitated by lead poisoning; report of five cases. *J.A.M.A.*, Sept. 1, 1951, *147*, 13–16.

The experience of the authors in hospital practice in Peru leads them to believe that plumbism is a factor in the precipitation of volvulus. They comment that in Peru as in the Baltic region and certain other world areas, volvulus accounts for about 50 per cent of cases of intestinal obstruction. Factors which seem to predispose to this occurrence of volvulus in adults and principally in the sigmoid are: (1) dietary roughage; (2) congenital development; (3) elevated altitude. Persons living at 12,200 feet altitude as did their patients, often experience "bloating," flatulence, anorexia, abdominal discomfort and diarrhea.

Case records of 5 patients are presented. All of these patients had worked in a lead plant eight to eighty-four months and all had pronounced evidence of lead absorption. Lead poisoning can simulate intestinal obstruction. Colicky pain, nausea, vomiting, obstipation and tenderness may be present in each. Distention is less common in lead poisoning and this difference might make it possible to differentiate the average uncomplicated case of lead poisoning with abdominal complaints from cases of intestinal obstruction of types not related to plumbism or volvulus.—*J. W. Turner, M.D.*

Spillane, Richard J., Kaiser, Thomas F., and Prather, George C. Medial deviation of the ureters complicating carcinoma of the rectum and sigmoid, and proctosigmoidectomy. *Surg., Gynec. & Obst.*, Sept., 1951, *93*, 273–282.

The two major factors which influence medial deviation of the ureters in cases of carcinoma of the sigmoid, rectosigmoid and rectum are: (1) pressure on the ureters from carcinomatous invasion of the pelvis with involvement of the iliac lymph nodes, and (2) peritonealization of the pelvic floor.

The mechanical implications of the first factor are obvious; the second cause might be obviated if care is taken to develop adequate pelvic peritoneal flaps and the pelvic floor is reconstructed without tension upon the ureters.

A distinction might be made in terminology. Medial fixation of the ureters could be considered the result of carcinomatous involvement whereas medial deviation should be reserved for the deformity which follows surgery.

Pyelographic studies of the intravenous type should be seriously considered as a routine preoperative procedure in all instances of lower bowel carcinoma, and as a postoperative procedure for data on the urinary tract.

The symptom-complex in the presence of ureteral obstruction is quite constant with oliguria, anuria, uremia, and death from massive hydronephrosis. The treatment is unsatisfactory, with nephrostomy the procedure of choice.

Summary. Nine cases of medial deviation of the ureters have been presented and the mechanics of this condition have been discussed. The pyelographic findings are diagnostic of: (1) local pelvic metastases from lower bowel carcinoma; (2) Miles' resection with recurrence of malignancy; and (3) combined abdominoperineal resection alone.—*Mary Frances Vastine, M.D.*

Gynecology and Obstetrics

Cuyler, W. Kenneth, Kaufmann, Louise A., Carter, Bayard, Ross, Robert A., Thomas, Walter L., and Palumbo, Leonard. Genital cytology in obstetric and gynecologic patients; a four-year study. *Am. J. Obst. & Gynec.*, Aug., 1951, *62*, 262–278.

This is a comprehensive study on cytologic interpretations on 51,022 smears from 15,217 obstetric and gynecologic patients over a period of four years. The procedures and classification of cytology are essentially those of Papanicolaou and colleagues. Classification of atypical cervical cytology from pregnant women is recommended.

Only 12.3 per cent of the women studied had what were judged to be normal elements in smear preparations whereas some degree of benign abnormalities was encountered in 80.4 per cent. False-negative and false-positive percentages are given—various methods of calculating false-positive error are illustrated and criticized.

Five hundred and ninety-four genital cancers were studied by smear preparations of which 447, or 75.2 per cent, consisted of squamous cell carcinoma of the cervix. Adenocarcinoma of uterus comprised 80, or 13.4 per cent, of the total number. Thirty-two, or 6.8 per cent, of the cervical cancers occurred in cervical stumps.

Ninety-five intra-epithelial carcinomas of the cervix were studied. These represent 0.62 per cent of all patients examined. The ratio of intra-epithelial carcinoma to squamous cell carcinoma of the cervix was 1:4.7.

Cold-knife conization of the cervix is considered to be the method of choice to provide adequate material for diagnosis of intra-epithelial and early invasive carcinoma of the cervix. The punch biopsy missed 18.5 per cent of the lesions.

The importance of correlating smear preparations with corresponding pathologic studies is emphasized.

The cost of cytologic studies is estimated to be as follows: $0.90 per smear; $3.00 per new patient; $2.00 per visit; $75.00 per malignancy studied.

The authors suggest that effort should be made to standardize reports of cytologic interpretation, the staining procedure, classification and the statistical methods employed. They feel that the method is of value for broad screening purposes, provided that interpretations are properly controlled. The detection of early cervical neoplasms is, perhaps, its greatest value. The identification for future study of the cervices which exfoliate benign but definitely atypical epithelial cells is important. —*C. P. Truog, M.D.*

Thornton, W. Norman, Jr., and Carter, John P. Sarcoma of the uterus, a clinical study. *Am. J. Obst. & Gynec.*, Aug., 1951, *62*, 294–302.

Twenty-four cases of sarcoma of the uterus, including 2 cases of sarcoma botryoides in children, were found in twenty-four years at the University of Virginia Hospital. Two were endometrial sarcomas, 14 were leiomyosarcomas, and 8 were of undetermined origin.

Presenting symptoms were postmenopausal bleeding (9), postmenopausal pain (4), enlargement of abdomen (2), menometrorrhagia (2), leukorrhea (2), urinary symptoms (2) and abdominal mass (1).

Seventeen cases developed sarcoma after menopause; in the other 5 it occurred while the patient was still menstruating. The 2 cases of sarcoma botryoides occurred in children five years and thirteen months of age. The disease was not suspected preoperatively in any of the adult cases although a tentative diagnosis of malignancy was made in 8 cases. Seven cases underwent dilatation and curettage prior to definitive surgery. The diagnosis of sarcoma was made from uterine scraping in 3 cases and suspected in a fourth.

Four of the patients had received intracavitary radium therapy more than ten years prior to the diagnosis of sarcoma. The maximum dose given was 2,400 mg. hr.

Two cases were considered inoperable and received only radiation therapy. Nineteen cases were treated surgically, 10 by total hysterectomy and 9 by subtotal hysterectomy. Eight of the patients treated surgically also received roentgen therapy. Of these 8 cases, 4 received roentgen therapy as an adjunct to surgery while the other 4 were treated later for local recurrences or metastasis.

The five year survival rate in adults was 8 per cent.—*C. P. Truog, M.D.*

Genitourinary System

Martin, K. Whittle. Purpura of the urogenital tract. *Brit. J. Urol.*, Sept., 1951, *23*, 233–249.

Purpura of the urogenital tract may occur in the two main types of generalized purpura, essential thrombocytopenia, so-called true purpura, and anaphylactoid purpura (Schönlein-Henoch syndrome). Renal purpura, of which 2 cases are presented, probably represents a distinct entity. In renal purpura the bleeding time and platelet count are normal and there is no associated generalized purpura. The condition is one of submucous hemorrhage confined solely to the urinary tract, is usually unilateral and is one of the causes of so-called essential hematuria. An unequivocal diagnosis of renal purpura cannot be made clinically. It may be strongly suspected but absolute proof of the diagnosis depends upon a careful postmortem or postoperative examination of the kidney and failure to

reveal a definite localized lesion to explain the hematuria.

Primary renal purpura is thought to represent a hypersensitivity reaction of the capillary endothelium to a specific antigen, either bacterial or abacterial. The bacterial antigen is more common and urinary tract infection is probably responsible for a majority of cases of renal purpura. The abacterial group includes cases of hematuria ascribed to drugs, such as iodides, or to food hypersensitivity.

Two cases of renal purpura are reported. The first had flank pain, persistent hematuria, minor urographic changes and a *B. coli* urinary infection. Examination of the kidney after operation showed petechiae of the kidney pelvis extending into the calyces with a purpuric patch in a calyx. Evidence of chronic pyelonephritis was present but no localized organic lesion was discovered. This was considered to represent renal purpura as a result of hypersensitivity to a bacterial antigen. The second case showed a persistent hematuria with normal blood values and normal urograms. A nephrectomy was done and the histologic findings were suggestive of a hypersensitive reaction. The pelvic mucosa showed a diffuse infiltration, including the submucosa, with red cells and with a large number of eosinophils. This hypersensitivity reaction was considered to be secondary to iodides which had been ingested as a medicament.—*Gerald Lavner, M.D.*

Nanson, Erick M. Primary carcinoma of male urethra. *Brit. J. Urol.*, Sept., 1951, *23*, 222–229.

The condition is uncommon but not rare. The author reports 2 cases which makes the total recorded number 189. The average age incidence is fifty-five years. Urethral stricture is mentioned as a potent etiological factor. It is presumed that squamous metaplasia and possibly leukoplakia precede malignant changes behind the stricture. The commonest site of occurrence is in the bulbomembranous urethra.

The symptoms are usually those of obstruction, tumor formation, ulceration and infection. There is no agreement as to the type of treatment best suited for these cases. The prognosis is generally conceded to be poor.—*A. E. Imler, M.D.*

Nervous System

Aird, Robert B., and Zealear, David. Pneumoencephalographic study of cerebrospinal-fluid absorptive-block mechanisms; a study of the mechanism involved in production of increased intracranial pressure. *Arch. Neurol. & Psychiat.*, Aug., 1951, *66*, 199–212.

In reviewing a large series of pneumoencephalograms, the authors noted the frequent occurrence of delayed absorption of the gases used in encephalographic injection (particularly ethylene and other rapidly absorbed gases) in patients who showed dilatation of the ventricular system and diminished or no subarachnoid filling. They have come to consider this triad of findings a roentgenological entity indicative of an absorption block.

Pneumoencephalograms were obtained in 1,272 patients who were studied clinically at the University of California Hospital. Follow-up studies to determine the absorptive rate of the rapidly absorbed gases (ethylene and oxygen) were adequate in 630 cases. The essential principles of the technique were: (1) Ethylene gas was used to replace the cerebrospinal fluid in most cases, oxygen (less rapidly absorbed) being used in only 45 cases. (2) The exchange of fluid and gas was made as complete as possible, 200 cc. being the upper limit considered desirable. (3) General anesthesia was used. (4) The exchange of gas and cerebrospinal fluid was done under constant pressure. (5) Routine and special studies were made immediately and follow-up roentgenograms in the lateral projections were made after three hours.

Correlation between the clinical diagnosis and the absorptive rates and between the pneumoencephalographic findings and the absorptive rates was made. Retention of 0–20 per cent of the gas at three hours was considered normal; 20–30 per cent retention, as borderline or slightly delayed absorption; and 30 or more per cent retention, as moderately or greatly delayed absorption.

The absorption rates were normal in most patients whose history did not suggest a pathological condition usually associated with alteration of cerebrospinal fluid dynamic equilibrium (infection, tumor, trauma). For example, patients with convulsive states without a history of infection or trauma showed normal absorption in 84 per cent while patients with convulsive states secondary to meningitis or meningoencephalitis showed normal absorption in only 44 per cent. Brain tumors, cerebrovascular disorders and degenerative disease also were manifested by delayed absorption in a high percentage of patients.

The characteristic roentgenographic picture associated with an absorptive block consists of small, streaky or obliterated subarachnoid channels and "large normal," or definitely dilated ventricles. The authors feel that a delay in absorption does not necessarily indicate decompensation in cerebrospinal fluid circulation but that it does suggest a limited margin of safety in the absorptive mechanism. In a progressive process, such as a case of low grade leptomeningitis, the early change foreshadows the alterations to come with progressive blocking of the absorptive bed, then increased intracranial pressure and hydrocephalus. The rate of disappearance of ethylene following pneumoencephalography is con-

sidered to be a relatively sensitive test for a partial obstructive process and may indicate such partial obstruction even before an increase in intracranial pressure has occurred. The fact that the above-mentioned triad of signs was noted in a significant number of patients with brain tumor suggests a common absorptive block mechanism for all space consuming and inflammatory lesions of the central nervous system.—*D. L. Rousseau, M.D.*

Beck, Stanley M., Jr., and Howard, Philip J. Neuroblastoma; review of the literature and report of a six-year cure by roentgen therapy. *Am. J. Dis. Child.*, Sept., 1951, *82*, 325–334.

The authors give a report of the number of cases of neuroblastoma in children found in the literature with particular attention to those cases in which the patients survived. It is important, they note, that 10 per cent of all reported cases are reported as "cures." In the paper, a review of the history, pathology, methods of diagnosis and therapy are presented.

Their patient was a white infant, male, three months old. A biopsy disclosed a tumor of the left adrenal gland. Immediate therapy was begun and the patient was given a series of 20 treatments in thirty-eight days with an estimated dose of 1,400 r to the tumor site in the upper part of the abdomen. Two months after the first course he was given a second course consisting of 16 treatments in twenty days with an estimated tumor dose of 1,250 r. The factors for the roentgen therapy were 200 kv. (peak), 50 cm. distance, half-value layer of 1.0 mm. Cu. The field size varied from 8 by 10 cm. to 15 by 15 cm. The patient's skin remained in good condition and he improved generally. The patient is living and well six years after diagnosis and treatment.

The case reported is of interest in that the infant at the age of nine weeks showed a well-developed acne illustrating androgen increase. Androgenic material is not secreted by the tumor tissue itself and must be understood as resulting from a mechanical stimulation from the nearby adrenal cortex. The authors stress the importance of early diagnosis and adequate treatment leading to a more favorable prognosis.—*R. S. Bromer, M. D.*

Skeletal System

Ruckensteiner, E. Über multiple Handwurzelknochen; eine röntgentomographische Studie. (Multiple carpal bones; a roentgen tomographic study.) *Röntgen-Blätter*, Sept., 1951, *4*, 237–243.

Because of the confusing overlying shadows seen in conventional roentgenograms of wrists containing supernumerary carpal bones, the author suggests the use of laminagraphy to investigate such cases. The laminagrams allow visualization of the size and shape of the extra bones as well as their relation to neighboring bones of the wrist, middle hand, and forearm. The sections should be as "thin" as possible and should be exposed with the hand in pronation and supination and in the lateral projection at the five levels of each metacarpal.

The case of a white female studied serially between the ages of seven and twenty-six years who exhibited fifteen carpal bones in each wrist is presented. Many of these accessory carpal bones could be identified and named as definite previously described accessory carpal bones; others represented bipartite carpal bones (*i.e.*, bipartite navicular and lunate). Laminagraphy aided in showing the position and relationships of these accessory ossification centers.—*Harold Fulton, M.D.*

Ford, G. D., Schneider, M., and Brandon, J. R. Congenital stippled epiphyses. *Pediatrics*, Sept., 1951, *8*, 380–392.

The authors give a brief review of the literature of this entity which has been described under various names, such as "dysplasia epiphysialis punctata," "chondrodystrophia calcificans congenita," and "stippled epiphyses." Caffey has emphasized that a distinction must be made between patients exhibiting punctate stippling of the epiphyses without evidence of growth disturbance and patients with typical achondroplasia and stippling of the growing cartilage.

The characteristic feature of the condition is the presence of multiple discrete areas of calcification in the growing cartilage of the epiphyses and apophyses. The onset is in fetal life. Most of the cases were discovered in the first year of life and most of the patients died of pulmonary or urinary tract infection. The etiology is obscure.

The authors report 2 cases in detail, including reproductions of illustrative films. One patient had typical chondrodystrophic dwarfism and the other no evidence of dwarfism. Multiple other clinical abnormalities have been described in the various previously reported cases. Among these are: flexion contractures, thickening of the skin, large fontanels, congenital cataracts, dulled intellect, and predominance of females over males.

The diagnosis depends on the roentgenographic findings. To be differentiated from the condition are the mottling and epiphyseal irregularity of dysplasia epiphysialis multiplex and the irregular ossification occasionally seen in hypothyroidism.—*R. M. Harvey, M.D.*

Josey, A. Izard. The importance of the cervical spine to the internist. *Ann. Int. Med.*, Aug., 1951, *35*, 375–390.

The author stresses the importance of two syndromes of the cervical spine which are frequently

overlooked. The first is a lateral rupture of an intervertebral disc of the lower cervical spine producing pain in the shoulder, arm and anterior chest. The second is headache associated with a pathological process, of as yet unknown etiology, in the upper portion of the cervical spine. Trauma may be an etiological factor in both of these syndromes.

The symptoms of lateral rupture of the lower cervical disc consist of neck pain and stiffness, shoulder, subscapular and arm pain. Numbness of the fingers depends upon the level involved. Pressure over the brachial plexus of the involved side produces pain and paresthesia into the arm and one or more fingers.

Roentgenograms of the cervical spine, as a rule, show a loss of normal curvature, a reversal of the curvature, narrowing of the intervertebral space and perhaps obliteration of the intervertebral foramen. The differential diagnosis is concerned with subdeltoid bursitis, arthritis, cervical rib and scalenus anticus syndrome.

The syndrome of headache associated with a loss of normal curvature on the lateral view of the cervical spine has been considered traumatic in many cases. The history of trauma may not be clear cut or impressive in all instances. The headaches are usually frequent, begin in the morning and are precipitated by movement of the head.

The author reports two series of cases illustrating the typical syndromes discussed.—*J. N. Ané, M.D.*

McCullough, Norman, B. Eosinophilic granuloma with multiple osseous and soft-tissue lesions in an adult. *Arch. Int. Med.*, Aug., 1951, *88*, 243–251.

It has been postulated by many that Hand-Schüller-Christian disease, Letterer-Siwe disease, and eosinophilic granuloma of bone represent different manifestations of the same disease. This view has been supported by Jaffe and Lichtenstein.

These conditions have been considered as limited to bone. Curtis and Cawley (1947) reported a case considered as eosinophilic granuloma with skin and bone manifestations in a sixteen month old girl.

McCreary (1948) published a case with bone and skin lesions in a two year old girl. Biopsy of both revealed the same type of lesion—eosinophilic granuloma. Pulmonary infiltrations and diabetes insipidus have been noted in patients with eosinophilic granuloma.

A case has been reported where eosinophilic granuloma of the mandible and adjacent lymph node was noted at nineteen months; diabetes insipidus at four years of age with no demonstrable osseous lesion; at six years, a large cervical node appeared, which had the characteristics of Hand-Schüller-Christian disease.

The author reports a case of eosinophilic granuloma in a twenty-four year old female with osseous and soft tissue manifestations. She was first seen at Billings Hospital in Chicago in July, 1947, and was observed for about two years. During the five preceding years, she had had recurrent gingival lesions, several teeth being extracted.

During the period of observation, multiple gingival lesions were noted. Soon perineal ulcers appeared which spread to the anal region as well as to the labia majora.

The bone lesions consisted of:

1. A defect 2 by 2 cm. in size of the right frontal bone, which corresponded to a clinically palpable depression. This had been preceded by a painless lump which receded spontaneously.

2. A lesion of the right sixth rib, anteriorly, with corresponding tender swelling. This was removed surgically.

3. A defect in the right lamina of C_5 including the right articular process.

4. Multiple defects in the maxilla and mandible which developed late during the period of observation.

Blood chemistry, including cholesterol, serum lipid, calcium, phosphorus, hematological and bone marrow studies, was negative. Sections from the resected sixth rib, the gum, and perineal lesions were typical of eosinophilic granuloma.

In May, 1948, diabetes insipidus developed. The patient's daily urine output varied between 7,000 and 9,000 cc.; water intake was about 7,900 cc. There was no bone destruction, and the sella was normal. Symptoms were controlled by 0.25 cc. of pitressin four times daily.

Radiation therapy, with a dose of 1,200 to 2,000 r to the perineal lesions and 1,500 r to the mandibular lesions, produced a cure of the treated lesions, while 2,700 r to the pituitary area controlled the diabetes.

Increasing prominence of the markings and linear densities in the upper lung fields was attributed to lung involvement by the same disease.

The occurrence of multiple soft tissue lesions and multiple bone lesions in an adult denotes the systemic nature of the disease and its similarity to Letterer-Siwe disease. The protracted course and spontaneous healing of the skull lesion, the response of the other lesions to radiation therapy, and the eventual quiescence of the disease denote the relatively benign nature of the process.—*W. H. Shehadi, M.D.*

Keizer, D. P. R., and Schilder, J. H. Ectodermal dysplasia, achondroplasia and congenital morbus cordis. *Am. J. Dis. Child.*, Sept., 1951, *82*, 341–344.

A case of a forme fruste of the Ellis-van Crefeld syndrome in a woman aged twenty-one is reported. The following abnormalities were noted in the patient: (1) osseous deformities superficially re-

sembling achondroplasia—short limbs and lordosis, peripheral chondrodysplasia in the hands and feet with shortening of the fourth digit, high vertebral bodies, exostoses on the ninth and tenth thoracic vertebrae and prognathous lower jaw; (2) ectodermal dysplasia—broken-off hairs, mouse teeth, dysplasia of the nails and ichthyosis; (3) congenital localized ventricular septal defect, Roger's disease; and (4) symptoms of slight thyrotoxicosis.

One important clinical feature was lacking in this case, namely polydactyly; also less obvious malformations, such as congenital fusion of the capitate and hamate bones and ectopia of the proximal center of the tibia as observed by Caffey in all the published cases, were missing. Unlike the patient reported by McIntosh in whom the congenital cardiac defect was lacking, in the authors' case the polydactyly and less obvious malformations were missing. They conclude that in the Ellis-van Crefeld syndrome, just as in dysostosis mandibulofacialis (Franceschetti-Zwahlen), both complete and incomplete forms (formes frustes) must be recognized. —*R. S. Bromer, M.D.*

Feldman, N., and Davenport, M. E. Osteochondrodystrophia deformans (Morquio Brailsford disease). *Arch. Dis. Childhood*, Aug., 1951, *26*, 279–288.

This is a report of 4 cases of osteochondrodystrophia deformans (Morquio Brailsford disease). Two of the patients were native African children and the other 2 were of mixed African and European origin. This osteochondrodystrophy, which results from an hereditary developmental defect in germ plasm, is characterized by a hyperplasia of cartilage growth. There is a definite familial tendency and consanguinity of parents has been reported in many cases. A history of consanguineous parents was obtained in 3 of the 4 cases in this report. The blood chemistry values, including calcium and phosphorus determinations, were normal in all of these cases.

The roentgenologic features are characteristic and include the following important findings:

1. Spine—There is an alteration of curvature with a dorsal or dorsolumbar kyphosis. The vertebral bodies are flattened, widened and irregular in outline. A characteristic tongue-like projection from the vertebral body was present in every case.

2. Skull—Two of the cases showed an enlarged calvarium and one, a basilar impression.

3. Long Bones—The diaphyseal ends are irregular and widened and the epiphyses are fragmented and irregular. The radius showed elongation in 2 cases. The tibia and fibula may be abnormally short and thick with sloping of their proximal ends.

4. Hips—The acetabula are widened, shallow and irregular in outline and the joint spaces show increased width. The proximal femora are deformed and the femoral necks are wider than usual. One case showed a coxa valga deformity.

5. Metacarpals and Phalanges—These are thick and short, show irregularity of their proximal extremities and have coarse trabeculation.—*Gerald Lavner, M.D.*

Blood and Lymph System

The Reticuloses

The following papers on this subject were read at three sessions of the symposium at the British Institute of Radiology, on January 18–19, 1951.

Part I. (First Session)

I. Symmers, W. St. C. Some comments on the pathology of the reticuloses. *Brit. J. Radiol.*, Sept., 1951, *24*, 469–475.

In view of the fact that so much in the field of the pathology of the reticuloses is still controversial and uncertain the author limits his discussion to some comments on their classification and certain aspects of their pathology. He defines reticulosis as "a local or generalized proliferation of lymphoreticular tissue, occurring in the absence of any underlying infection, metabolic disturbance or other cause which can be demonstrated by methods at present available."

For lack of a generally agreed histopathological classification, although many have been proposed, the author suggests the following simple clinicopathological classification: (A) benign reticulosis, of which the lymphohistiocytic medullary reticulosis of Robb-Smith's classification is the only one occurring rather frequently; (B) potentially malignant reticulosis, as for example Brill-Symmers disease (Brill, Baehr and Rosenthal, 1925; Douglas Symmers, 1927); and (C) malignant reticulosis and the lymphoreticular sarcomas, comprising Hodgkin's disease and its related conditions, the Letterer-Siwe syndrome, the acute histiocytic medullary reticulosis described by Bodley Scott and Robb-Smith (1939), and the primary sarcomas of the lympho-reticular system.

The various pathological aspects commented upon include: the microscopic diagnosis of hyperplasia and neoplasia which in a given borderline case may vary from histologist to histologist; the nature of Hodgkin's disease which still remains unsettled; the question of dermatopathic lymphadenopathy as, for example, in generalized erythrodermia or exfoliative dermatitis, the author being of the opinion that such lymphadenopathy is not in itself a potentially malignant condition and that whenever a malignant process is present this is usually the primary and the skin manifestations are consecutive results; and the debatable triad of Letterer-Siwe syndrome, Schüller-Christian disease

and eospinophilic granuloma of bone. In connection with this latter group of diseases, he doubts whether, as Jaffe and Lichtenstein (1944) state, they are different expressions of one basic disorder, a peculiar inflammatory histiocytosis, although the triad exemplifies a possible relationship between (1) an acute and lethal reticulosis, (2) a condition which has hitherto been regarded as a primary lipoidosis and (3) a benign granuloma-like lesion.—*T. Leucutia, M.D.*

II. Scott, Ronald Bodley. Some clinical aspects of the reticuloses. *Brit. J. Radiol.*, Sept., 1951, *24*, 475–478.

The author believes that the complicated classification of reticuloses by Robb-Smith (1938, 1947), with whom he was associated, has a practical value to the clinician. Since a general review of the clinical characteristics of all reticuloses in the allotted time is impossible he limits himself to a few disconnected observations.

As regards Hodgkin's disease, he states that irradiation should include only the manifest lesions. Prophylactic treatment of the regional or more distant areas seems irrational, since radiation therapy in this disease is palliative but never curative. He recommends that as small a dose be given as will dispose of the local tumor, except when a combination of surgical extirpation and postoperative irradiation is used, in which case the dose should be larger. Pregnancy does not alter the normal progress of Hodgkin's disease; therefore it is safe to allow it to proceed to term.

The second disease discussed is the lymphoreticular medullary reticulosis of the Robb-Smith classification, which is closely related to Hodgkin's paragranuloma of Jackson and Parker. The author believes, however, that the cases of Jackson and Parker which change into Hodgkin's disease (about one-fifth) are instances of lymphadenoma verum since he himself has never seen such metamorphosis. The lymphoreticular medullary reticulosis is considerably more benign than true lymphadenoma. More than 50 per cent of the patients afflicted with this disease survive five years and 5 per cent are alive after fifteen years.

A third disease in this group is lymphoid follicular reticulosis, or Brill-Symmers disease, which likewise has a relatively more benign course. On an average, 50 per cent of the patients with this disease survive five years and 10 per cent for ten years.

Clinical characteristics of other less common varieties are also briefly discussed.—*T. Leucutia, M.D.*

III. Golding, F. Campbell. The radiological diagnosis of the reticuloses. *Brit. J. Radiol.*, Sept., 1951, *24*, 478–485.

In discussing the value of the roentgenological examination in the diagnosis of the various types of reticuloses, the author brings out the following pertinent facts:

In Hodgkin's disease osseous involvement occurs in 1 out of 10 cases. The lesions present in three forms, the osteoplastic, the osteolytic and the combined form, the last being the commonest. It may cause ivory vertebra and may produce destruction of the body of a vertebra with paravertebral shadow, resembling tuberculosis.

In the leukemias attention is called to two rather unknown signs. One is a characteristic erosion of the medial side of the proximal metaphyses of the humeri in lymphatic leukemia of children, although a similar lesion has been seen in other children with no adequate explanation. The second is a slight, but widespread homogeneous increase in density of long bones in myeloid leukemia.

In the group of lipoid and nonlipoid reticuloses, the roentgenological interpretation may prove difficult. It is customary to consider at present Hand-Schüller-Christian disease, eosinophilic granuloma and Letterer-Siwe disease as various expressions of the same disorder, but this may not satisfy the clinician ten years hence. The author stresses the part that aseptic necrosis plays in Gaucher's disease. He also cites 2 cases which appeared to be transitional forms between Letterer-Siwe disease and eosinophilic granuloma. He suggests that these forms be called benign and malignant nonlipoid reticuloses since in one case the lesions regressed spontaneously. The malignant form may pass as Ewing's tumor with metastases to bone, reticulum cell sarcoma or multiple myelomatosis.

The article is richly illustrated with reproductions of interesting roentgenograms.—*T. Leucutia, M.D.*

Part II. (Second Session)

I. Levitt, Walter M. Treatment of reticulosis by x rays. *Brit. J. Radiol.*, Sept., 1951, *24*, 485–490.

The author confines himself to a discussion of the treatment of the primary lymphadenopathies, of which the classical type is Hodgkin's disease. He also refers briefly to reticulosarcoma.

The procedure used varies according to the stage of the disease. The following stages are considered:

Stage I: a single mobile lymph node or small mass limited to a superficial lymph node area. Only very few cases are encountered in this stage. A few cures are reported in the literature following surgical excision and postoperative deep roentgen therapy, which should not be carried to the point of skin damage.

Stage II: a large mass which is too extensive for radical surgery but is still limited to a single superficial lymph node area. In this stage the author recommends the administration of a "disappearance dose" plus a reasonable margin, the aim being to

conserve the skin as much as possible for future irradiation. Usually a dose of 1,200–1,500 r is given in two weeks to the initial lesion as well as to the nearest deep lymph node area; *i.e.*, the mediastinum in case of cervical lymphadenoma; the pelvis, in the male and the menopausal female, where the initial lesion is in the groin. In the lymphoid follicular reticulosis, the prophylactic irradiation of the nearest deep lymph node area is omitted to preserve the maximum constitutional tolerance for later events. Surgical excision is advised for mobile remnants after irradiation.

Stage III: enlargement of superficial lymph nodes localized to one area, together with enlargement of the related deep lymph nodes, the commonest combination being neck and mediastinum. In this stage the superficial and deep lymph nodes are irradiated separately.

Stage IV: deep masses limited to a segment of the body, the commonest distributions being: (1) neck, axilla and mediastinum, the lesion spreading out to the lung fields; (2) liver, spleen and epigastrium, often associated with basal pulmonary lesions; and (3) groin and deep pelvic lymph nodes. In this stage "bath" irradiation of the affected segment is employed. The author elsewhere described in detail the technique used for the three segments, called the thoracic bath, mid-bath and pelvic bath. Usually four oblique fields are used, every beam covering the whole of the segment, and a uniform dose of 2,000–2,500 r is given over a period of about one month. This necessitates about 1,000 r per field. The volume dose is high but well tolerated. Not one single death attributable to treatment was observed in over 400 consecutive cases. Marked symptomatic relief was produced regularly, with remissions lasting for many months and, in some cases, even for a number of years.

Stage V: complete generalization of the disease. In this stage a "bath" irradiation of the whole trunk with a dose up to 500–600 r may be carried out by protecting the long bones. However, the really striking successes are rare (in only 2 cases out of 40 cases of the author's series). In certain instances of suspected Hodgkin's disease with Pel-Ebstein fever but without evidence of manifest lesions, a mid-bath is indicated, and when the temperature falls towards the end of the first week, the diagnosis may be considered as confirmed. Otherwise, the treatment is discontinued after a fortnight.—*T. Leucutia, M.D.*

II. Hilton, Gwen. Some observations on the reticuloses and the treatment by x rays. *Brit. J. Radiol.*, Sept., 1951, *24*, 491–494.

The author uses the term "invasive phase" to denote the spread of reticulosis outside the capsule of a lymph node into the surrounding soft tissues in contradistinction to involvement of multiple lymph nodes in many parts of the body. The differentiation is important from the point of view of prognostic evaluation since in the latter instance the disease can be controlled for a number of years, provided it does not become invasive. The assertion that radiation therapy precipitates the invasive phase does not correspond to actual facts.

She also believes that a very simple breaking up of the group of reticuloses is helpful as a rough guide to treatment and particularly to prognosis. She uses a classification based on that of Gall and Mallory which is as follows: (1) Hodgkin's disease; (2) Hodgkin's sarcoma; (3) giant follicular lymphoma; (4) reticulosarcoma; (5) lymphoblastic and lymphocytic lymphomas; (6) mycosis fungoides.

The prognosis and dosage are discussed in each entity. It is emphasized that every case must be treated individually.—*T. Leucutia, M.D.*

III. Boden, Geoffrey. Results of the x-ray treatment of the reticuloses. *Brit. J. Radiol.*, Sept., 1951, *24*, 494–498.

The author presents a statistical analysis of the results in 298 cases of reticuloses treated by roentgen therapy at the Christie Hospital of Manchester between 1940 and 1944. All cases in which there was a doubt as to the diagnosis have been eliminated and the results expressed in five year crude survival figures.

Table I

RETICULOSIS 1940–1944—RESULTS AT FIVE YEARS
Total 298 cases

Reticulosis	No. Cases	Alive	Not Traced	Intercurrent Death	Per Cent Crude Survival
1. Sarcomata	152	45	1	2	30
2. Hodgkin's disease	112	29	2	0	26
3. Other reticuloses	34	20	0	0	59

A very simple grouping was used in making the tabulation, consisting of (1) the sarcomata, (2) Hodgkin's disease and (3) other reticuloses.

The over-all results for the three groups are shown in Table I.

A further breaking up of these groups gave the following five year crude survival figures:

(1) Sarcomata: lymphosarcoma (95 cases) 28 per cent, reticulosarcoma (39 cases) 28 per cent and indeterminate sarcoma (18 cases) 39 per cent.

If the localized cases were separated from the generalized cases the values were: (a) localized: lymphosarcoma (50 cases) 50 per cent, reticulosarcoma (19 cases) 53 per cent, and indeterminate sarcoma (10 cases) 60 per cent; and (b) generalized: lymphosarcoma (45 cases) 4 per cent, reticulosarcoma (20 cases) 5 per cent, and indeterminate sarcoma (8 cases) 13 per cent.

(2) Hodgkin's disease: (a) localized (38 cases) 53 per cent; (b) generalized (74 cases) 12 per cent.

(3) Other reticuloses: lymphoid follicular (9 cases) 67 per cent; unspecified (14 cases) 50 per cent; mycosis fungoides (3 cases) 67 per cent; myelomatosis (2 cases) 50 per cent and endothelioma (6 cases) 67 per cent.

The irradiation was carried out along identical lines in all groups. The generalized cases were treated mostly for palliation, the dosage levels rarely exceeding half of the tolerance for the appropriate volume being irradiated. The localized cases were treated as follows: (a) the field extended 5 cm. beyond the lesion or lymph node group in every direction; (b) the whole of the anatomical lymph node group or groups associated with the lesion were included in the zone to be treated; and (c) the zone was irradiated as one undivided volume.—*T. Leucutia, M.D.*

Part III (Third Session)

I. Russell, Brian. Cutaneous manifestations of the reticuloses. *Brit. J. Radiol.*, Sept., 1951, *24*, 498–503.

This paper exemplifies the approach to the problem of reticuloses from the point of view of the dermatologist. For many years syphilis has been responsible for the largest number of skin manifestations. Recently it was superseded by the drugs so often used in chemotherapy. The reticuloses, or lymphomas, follow as a close third, producing skin eruptions of the most varying kind likely to lead to serious and embarrassing errors.

The author gives a detailed description of the cutaneous manifestations in (1) mycosis fungoides, (2) Hodgkin's disease, (3) reticuloses terminating with leukemia, (4) lymphocytomata, and (5) histiocytoses with secondary cholesterosis.

It is emphasized that sometimes the diagnosis may be very difficult and that prolonged observation and repeated biopsies may be necessary before the true nature of the reticulosis is established.—*T. Leucutia, M.D.*

II. McWhirter, Robert. Chemotherapy in the treatment of malignant disease. *Brit. J. Radiol.*, Sept., 1951, *24*, 503–507.

The author gives the chemical formulae and discusses briefly the dosage and after-effects of the following more recent drugs used in the treatment of idiopathic reticuloses and the reticulum cell sarcomas:

The intravenous nitrogen mustards: methyl bis (beta chloroethyl) amine, 3–5 mg. daily for four to seven days. The tris compound was also used but was found to be more toxic than the bis compound.

The oral nitrogen mustards: Haddow, Kon and Ross prepared a large number of these compounds. The most commonly used are the R48, in initial doses of 200–400 mg., followed by 100–200 mg.; and the R151, in initial doses of 50–100 mg., followed by 25–50 mg. The latter is the less toxic of the two.

Folic acid antagonists: The aminopterin is the only compound of this group which has a definite therapeutic value in acute lymphatic leukemia of children. The initial dose is 1 mg. daily, reduced later to 0.5 mg. per day.

Stilbamidine: This drug was used in only 2 patients by following the procedure of Snapper. There was little temporary benefit and both patients developed the trigeminal symptoms.

The author's personal experience in Edinburgh has been confined mainly to the oral nitrogen mustards (R48 and R151). A series of 81 cases was treated, distributed as follows: (a) leukemias, 31 cases; (b) idiopathic reticuloses, 22 cases; (c) reticulum cell sarcoma, 13 cases; (d) multiple myeloma, 8 cases; and (e) miscellaneous, 7 cases.

Under the heading of idiopathic reticuloses are included Hodgkin's disease and giant follicular lymphoma which are divided into localized and generalized. At this stage no definite conclusion can be drawn, but it appears that 3 out of 11 cases of localized idiopathic reticuloses obtained some benefit and 5 out of the 11 cases of generalized reticuloses showed at least temporary improvement. The author emphasizes, however, that roentgen therapy must remain the treatment of choice in the localized forms of both the idiopathic reticuloses and the reticulum cell sarcoma. The administration of mustards should be restricted to the radiation-fast or very advanced cases.—*T. Leucutia, M.D.*

III. Nabarro, J. D. N. Nitrogen mustard therapy in the reticuloses. *Brit. J. Radiol.*, Sept., 1951, *24*, 507–510.

The author reports on the results obtained with two nitrogen mustard compounds: the intravenous dichloroethyl methylamine hydrochloride (mustine)

and the oral aromatic di(2-chloroethyl)-beta-naphthylamine (R48).

He describes in detail the toxic effects, complications and clinical indications which must be considered when using these two preparations.

The series included 41 patients treated with intravenous mustine and 22 patients treated with oral R48. Some benefit was obtained in Hodgkin's disease, especially in the generalized forms. In the other malignant lymphomas, the results were less encouraging.

The conclusion is reached that this form of treatment should be regarded only as an adjuvant to roentgen therapy.—*T. Leucutia, M.D.*

IV. Galton, D. A. G. Aromatic nitrogen mustards in the reticuloses; with special reference to R48 [di(2-chloroethyl)-beta-naphthylamine]. *Brit. J. Radiol.*, Sept., 1951, *24*, 511–513.

With the aim of separating the growth-inhibitory and toxic properties of the nitrogen mustards, Haddow and others in 1947 synthesized a large series of aromatic analogues of the nitrogen mustard. Four of these (R74, R50, R48, and R151) were submitted for clinical trial.

The author carried out investigations on a larger scale with R48 given orally at the Royal Cancer Hospital, London, during 1948 and 1949. Sixteen cases of lymphosarcoma and 11 cases of Hodgkin's disease were treated. Of the 27 cases only 2 patients with generalized Hodgkin's disease obtained definite benefit, in both lasting for one year and six months.

It thus became evident that the advantage of relatively low toxity of the new preparation was counterbalanced by marked decrease in its therapeutic efficacy. The author believes, however, that, since R48 is the first active member of a series, search for a more suitable compound should be continued.—*T. Leucutia, M.D.*

V. Boland, J. Clinical experience with nitrogen mustard in Hodgkin's disease. *Brit. J. Radiol.*, Sept., 1951, *24*, 513–515.

The author deals with the results obtained in 102 cases of Hodgkin's disease treated with nitrogen mustard at the Christie Hospital in Manchester under the care of Dr. Edith Paterson. Admittedly, the greatest benefit was obtained in this condition, so that in the other reticuloses nitrogen mustard therapy has already been replaced by the administration of newer chemotherapeutic agents on trial.

Two treatment policies have been pursued: (1) in a first series courses of 0.4 mg. per kg. body weight were given at intervals of six to nine weeks, regardless of whether a relapse was present or not; (2) lately this method has been replaced by one in which an initial course of 0.4 mg. per kg. is given in two days and further treatment is repeated only in case of recurrence of symptoms.

It is too soon to give long-range statistical compilations as yet, but the author compared a group of 105 cases of Hodgkin's disease treated from 1940 to 1944 by roentgen therapy alone with another group of 82 cases treated during 1946 and 1947, in one-third of which nitrogen mustard therapy was given mostly supplementary to roentgen therapy, and in a few advanced cases as the sole method. The three year survival rate was 33 per cent in the first and 40 per cent in the second group, and the average duration of life of those patients who died within the three years was eleven months and fourteen months, respectively.

The author, therefore, feels that nitrogen mustard has a real place as a routine therapeutic agent in the management of Hodgkin's disease.—*T. Leucutia, M.D.*

Hodgson, John R., Kennedy, Roger L. J., and Camp, John D. Reticulo-endotheliosis (Hand-Schüller-Christian disease). *Radiology*, Nov., 1951, *57*, 642–652.

In the original description of Hand-Schüller-Christian disease, Letterer-Siwe disease and eosinophilic granuloma, definite clinical, pathological and roentgenologic features were ascribed to each disease.

The classic triad of Hand-Schüller-Christian disease is diabetes insipidus, exophthalmos, and granulomatous lesions in the calvarium. The disease occurs in children or adults in chronic form. The skeletal lesions usually heal as a result of replacement of reticulo-endothelial cells with fibrous tissue and cholesterol deposits.

Letterer-Siwe disease occurs in infancy or early childhood and is characterized by splenomegaly, hepatomegaly, hemorrhagic tendency, generalized lymphadenopathy, localized tumors over bones, secondary anemia, increase in nonlipoid containing macrophages, and relatively short duration with fatal outcome.

Eosinophilic granuloma of bone is almost always found in children or young adults and is characterized by pain and local swelling. The lesions may be solitary or multiple, generally involving the long bones.

Although specific histopathological descriptions have been given for these variants, later authors differed in their opinion as to the histopathological appearance, presumably because of studying different stages of the pathological progress.

The present authors reviewed the roentgenograms in 28 cases of reticulo-endotheliosis. Their study revealed several examples which were interpreted as transitional forms of the disorder. In a review of the literature and correlation of their own cases, they mention, as example, that many cases have been seen with parts of the classic triad of Hand-Schüller-

Christian disease missing, or with other added signs and symptoms including lymphadenopathy, skin lesions, splenomegaly, hepatomegaly, pulmonary involvement, anemia, and disorders of the blood.

They believe all three of these conditions should be considered as reticulo-endotheliosis. The roentgen manifestations are described as areas of destruction, multiple or solitary, and involving one or more bones. The skull is usually involved. Other bones most commonly affected are the pelvis, femurs, ribs, humeri, mandible and scapula. Periosteal reaction is lacking in the skull. Lesions of the long bones are usually at the ends, sparing the epiphyses. There may or may not be expansion of the shaft. There may be a destruction of the inner surface of the cortex and resulting pathological fracture. Periosteal reaction is common.

Pulmonary involvement usually consists of a fine nodular density scattered throughout the lungs along the distribution of the bronchovascular markings.

The disease may involve the mandible, producing a destruction of bone around the roots of the teeth unlike any other disease.

In the differential diagnosis they consider metastatic carcinoma, multiple myeloma, meningiomas, epidermoid cysts, osteomyelitis, Ewing's sarcoma, chondromas, giant cell tumors, and fibrous dysplasia.

The average duration of active disease in cases seen at the Mayo Clinic was slightly more than two years. In general, the prognosis is good, but the younger the child, the poorer the outlook.—*E. E. Seedorf, M.D.*

Childs, Donald S., Jr., and Kennedy, Roger L. J. Reticulo-endotheliosis of children; treatment with roentgen rays. *Radiology*, Nov., 1951, *57*, 653–660.

Roentgen therapy as the main therapeutic agent is apparently of value in any type of reticulo-endotheliosis. The authors emphasize that it is often difficult to assign the individual patient to one of the three general types, Letterer-Siwe disease, Hand-Schüller-Christian disease or eosinophilic granuloma of bone. It is common for a single patient to display characteristics of more than one of these groups.

Twelve children, all four years of age or younger, were treated by roentgen irradiation and in 9 the disease is considered arrested while 3 patients died from the disease. The treatment usually consisted of 200 r in air generated at 130 kv. and with a half-value layer of 0.3 mm. of copper. The estimated tumor dose was 200 r per lesion. Lesions were present in the skull in all patients while other bones were involved in all but one. In 6 patients enlargement of the lymph nodes, spleen and liver was noted.

The response to radiation therapy was prompt except in the 3 who died. Lymph nodes regressed within ten days and evidence of healing of bone lesions was noted within thirty days. In most cases at least three courses of treatments (total tumor dose 600 r) were necessary to control any specific lesion.

The authors stress the fact that since the disease may not be fatal, the total roentgen dosage must be kept as small as possible to avoid late deleterious effects such as altered growth of bone and teeth.—*C. A. Stevenson, M.D.*

Symposium on Hodgkin's Disease, Lymphosarcoma and Reticulum Cell Sarcoma

I. Perussia, Felice. Introduction. *Radiol. clin.*, July, 1951, *20*, 220–224.

This introduction is the opening address delivered by Professor Felice Perussia, Director of the Institute of Radiology of the University of Milan, before the Swiss Society of Radiology at its Annual Meeting held on May 5 and 6, 1951, at Lugano. The occasion was a symposium on Hodgkin's disease, lymphosarcoma and reticulum cell sarcoma which constituted the main topic of the meeting and in which some of the most eminent authorities on this subject participated.

Rightly, Professor Perussia emphasized the many difficulties encountered in the classification of the tumors of the reticulo-endothelial system.

As regards the treatment of Hodgkin's disease, lymphosarcoma and reticulum cell sarcoma, Professor Perussia is convinced that radiation therapy will continue to occupy the most important place. Surgical excision may be useful in some of the early localized lesions, but intensive postoperative irradiation of the primary site and regional areas must be carried out whenever such patients are referred to the radiotherapist. Experience with nitrogen mustard at the Institute of Cancer of Milan proved rather disappointing. Although rapid regression of the tumefactions was noted in some cases of Hodgkin's disease, this was usually of only temporary duration. In other cases, the cytotoxic effect produced, particularly on the blood elements, led to aggravation of the condition of the patient. Nitrogen mustard was of limited value only in radiation-fast cases of Hodgkin's disease in bringing about some remission in the terminal stage. The radioactive isotopes, such as radiophosphorus and radiomanganese, yielded, in those institutions in which they were used, results which likewise are inferior to those obtained by radiation therapy.—*T. Leucutia, M.D.*

II. Walthard, B. Pathologische Anatomie des Lymphogranuloms, Lymphosarkoms und Reticulosarkoms. (Pathologic anatomy of lymphogranuloma, lymphosarcoma and re-

ticulosarcoma.) *Radiol. clin.*, July, 1951, *20*, 224–254.

Professor Walthard, Director of the Institute of Pathology of the University of Bern, in this excellent and amply illustrated paper, discusses in extenso not only the pathology and histopathology of the three lesions composing the symposium but also their histogenetic origin and their relationship with the reticulo-endothelial system as a whole. He begins with the mesenchyme cell and proceeds to show how through various phases and degrees of differentiation a single mother cell can give rise to enormously complex structures which are most difficult to classify in an orderly manner.

Professor Walthard suggests the following classification:

I. Embryonal mesenchymal elements.
II. Reticular tissue:
  1. with unmasked reticulum: bone marrow, lymph nodes and lymphoid tissue, spleen, connective tissue;
  2. with masked reticulum: cartilage, bone.
III. Elements of the reticular system: connective tissue cells, reticulum cells, endothelial cells, blood cells.
IV. Reticulo-endothelial system (Aschoff) as a functional unit.
V. Regressive changes of reticular tissue.
VI. Heterotopic reticular tissue.
VII. Reticular tissue in inflammatory processes:
  1. acute inflammation
  2. granulation tissue: hystiocytic-myeloid components
  3. specific granuloma: transition into systemic diseases and malignant tumors of the reticular tissue.
VIII. Generalized diseases of the reticular tissue Reticuloses:
  1. simple undifferentiated form:
    lymphocytic cell type (acute, subacute, chronic), transition into monocytic leukemia;
  2. differentiated forms with storage of metabolic products
    storage diseases:
    Gaucher's disease,
    Niemann-Pick disease,
    Schüller-Christian disease;
  3. differentiated forms with predominance of blood cells:
    leukemic reactions,
    aleukemic leukoses,
    true leukemias,
    stem cell leukemias with tumor-like behavior,
    transitional forms into systemic diseases and malignant tumors of the reticular tissue.
IX. Malignant tumors originating from reticular tissue:
  1. Brill-Symmers giant follicular lymphadenopathy,
  2. lymphosarcoma — lymphosarcomatosis — lymphatic leukemia,
  3. lymphoid and interstitial reticulum cell sarcoma of the lymphatic tissue and bone marrow (Ewing-Kahler)—reticulosarcomatosis—monocytic (stem cell) and plasma cell leukemia,
  4. transitional forms,
  5. sarcomas with highly differentiated intercellular substance.

The etiology and pathogenesis of most reticular processes, and especially of the lymphadenoses, are unknown. Diametrically opposed theories are often advanced for their explanation.

In practice, it is often found difficult:

(1) to determine in a given case whether one is dealing with an inflammatory reaction (granuloma), or a generalized reaction (reticulosis) or a true malignant neoplasia (reticulum cell sarcoma);

(2) to evaluate the origin of the cells responsible for the mesenchymal neoplasia;

(3) to estimate whether in case of generalization this is the result of a metastatic dissemination of a malignant neoplasm or of a systemic regulatory disturbance of the reticulo-endothelial system.

Professor Walthard closes by affirming his awareness of the many unsolved problems which still exist in the domain of these exceedingly complex mesenchymal tissue reactions.—*T. Leucutia, M.D.*

III. Martin, Eric. Lymphogranulome, lymphosarcome et réticulosarcome. Traitement médical. (Lymphogranuloma, lymphosarcoma and reticulum cell sarcoma; medical treatment.) *Radiol. clin.*, Sept., 1951, *20*, 295–312.

In discussing the medical treatment of these conditions, Professor Martin of Geneva, as a clinician, pays considerable attention to the value of the drugs which have been introduced more recently. He deals in detail with the use of urethane, nitrogen mustards, folic acid derivatives and antagonists, and ACTH and cortisone.

The following general conclusions are reached: Chemical agents may be used concomitantly or supplementary to radiation therapy for the treatment of Hodgkin's disease, lymphosarcoma and reticulum cell sarcoma. Insufficient time has elapsed to properly judge their real value as yet.

In Hodgkin's disease the nitrogen mustards produce a rapid and more general effect than does radiation therapy but this effect is of shorter duration and not altogether harmless. The present trend

is to find a preparation suitable for oral administration and to use chemotherapy in association with radiation therapy. The conventional medical procedures include repeated blood transfusions, the administration of Fowler's solution, a diet rich in active principles and vitamins, proper management of the case and not infrequently well planned psychotherapy. A close collaboration between the internist, surgeon and radiotherapist is essential for the success of treatment.—*T. Leucutia, M.D.*

IV. Gilbert, René-J. Lymphogranulome, lymphosarcome, réticulosarcome. Radiothérapie. (Lymphogranuloma, lymphosarcoma, reticulum cell sarcoma; radiation therapy.) *Radiol. clin.*, Sept., 1951, *20*, 313–336.

Professor Gilbert, Director of the Institute of Radiology of the University of Geneva, whose many outstanding publications on radiation therapy are universally known, reviews in his paper the present status of this form of treatment as it applied to Hodgkin's disease, lymphosarcoma and reticulum cell sarcoma.

Hodgkin's disease. In view of the great variation in the clinical course of Hodgkin's disease, Professor Gilbert, in association with Babaiantz and Kadrnka, already in 1934 proposed that the following three forms be distinguished: (I) rapid form (duration less than two years), (II) medium chronic form (duration from two to six years) and (III) slow chronic form (duration more than six years). The fourth or acute form does not come into consideration from the point of view of radiation therapy. This classification is made in retrospect for statistical purposes but the acquired clinical experience permits a fairly close evaluation during the patient's life. Of 111 patients treated up to January, 1945 (minimum of six year interval), 32 patients (29 per cent) belonged to Group I, with no survival; 48 patients (43 per cent) to Group II, with no survival; and 31 patients (28 per cent) to Group III, with 17 having survived six years or longer. The average survival from the time radiation therapy was instituted, was in Group I, eight months; in Group II, two years and eight months; and in Group III, twelve years and six months.

The second factor which seemed to influence the prognosis is the degree of clinical extension of the Hodgkin's disease at the time radiation therapy was started. This same factor induced Peters of Toronto to propose recently (Am. J. Roentgenol. & Rad. Therapy, 1950, *63*, 299–311) the following classification: Stage I, involvement of one single lymph node region, or a solitary lesion elsewhere; Stage II, involvement of two or more proximal lymph node regions confined to the upper or lower part of the trunk, with or without general symptoms; and Stage III, involvement of multiple lymph node regions, with or without general symptoms, or acute forms with no obvious lymphatic involvement. Whereas Peters reported 35 per cent of her cases as belonging in Stage I, with a 100 per cent five year survival, Professor Gilbert, in his series had only 6 per cent in Stage I, but this was compensated by the fact that 40 per cent of his Stage II cases and 7 per cent of the Stage III cases represented slow chronic forms of Hodgkin's disease. Obviously, the consideration of the natural clinical course is just as important as the knowledge of the clinical stage in evaluating the prognosis of Hodgkin's disease.

Other factors of lesser significance are: the individual clinical response of the disease, the technique and procedure employed in administering radiation therapy and the degree of radiosensitivity in the particular case. These factors are discussed in detail and several case records are included in short résumés to illustrate the pertinent points of interest.

Lymphosarcomas: (a) macrofollicular lymphoblastoma, or Brill-Symmers disease; (b) true lymphosarcoma; (c) chronic lymphatic leukemia.

Professor Gilbert analyzes the value of radiation therapy in this group of diseases on the basis of personal observations and many reports cited from the literature. Among these latter are the publications of Cocchi and E. Meier, Jackson and Parker, Sorin, Sugarbaker and Craver, R. Paterson, Lawrence, Naegeli and others.

Reticulum cell sarcoma. This lesion is dealt with in a similar manner. The contributions of Edling, Santagati, Gardini, Sugarbaker and Craver are reviewed and the available data, especially in regard to dosage, coordinated.

The over-all conclusion is reached that in Hodgkin's disease, lymphosarcoma and reticulum cell sarcoma radiation therapy constitutes the treatment of choice. Surgical excision is used exceptionally. In the early localized cases long-range survivals of five, ten and fifteen years or more may be obtained. In the remainder the palliation produced is usually appreciable, resulting in definite prolongation of the useful life. In order of decreasing frequency the greatest benefit is observed in Hodgkin's disease, localized lymphosarcoma and Brill-Symmers disease. Reticulum cell sarcoma, the generalized lymphosarcomas and the chronic lymphatic leukemias have a more severe prognosis, although exceptions may be found in each of them. The chemotherapy and radioactive isotopes, in their present state, have proved disappointing. Used alone, none of these agents gives results comparable to those obtained by well conducted radiation therapy, except perhaps radiophosphorus in selected cases of lymphatic leukemia. On the other hand, nitrogen mustard and triethylene-melamine constitute valuable adjuvants to radiation therapy in the generalized forms and in the radiation-fast cases of Hodgkin's disease.—*T. Leucutia, M.D.*

LEB, A. Die Röntgen-Serienvasographie des periarticulären Gefässapparates bei der rheumatischen Polyarthrose. (Roentgen serial vasography of the periarticular vascular apparatus in rheumatic polyarthrosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Sept., 1951, *75*, 251–258.

Roentgenograms of the hand were made at five second intervals for a minute, and at fifteen to thirty second intervals for another minute or two, after the injection of 6 to 12 cc. of thorotrast into the brachial artery in the elbow region. Thorotrast was used because other contrast media produced vasospasm. The time intervals were chosen so as to demonstrate arterial inflow, the transition period, and venous outflow.

Normally the arteries are visualized to the region of the distal phalanges, and in the transition period a rich anastomotic network is visible here.

In cases with degenerative joint disease the distal portions of the arteries are narrowed or not demonstrable; there is delay in the venous filling, and occasionally varicosities of the veins are present.

One case with minimal demonstrable joint change and marked vascular disturbance is cited as proof that the circulatory disturbance is primary to the joint changes.—*J. J. B. Light, M.D.*

LOOSE, K. E. Die Aortographie in der Diagnostik peripherer Gefässleiden. (Aortography in the diagnosis of peripheral vascular disease.) *Chirurg*, Sept., 1951, *9*, 394–398.

The most important aspect of vasography is roentgen visualization of all sections of the arteries of the examined region of the body. In the past, roentgen examination in peripheral vascular disease of the lower limb has usually been restricted to the arteries of the leg and the pelvic arteries have often been neglected. Other authors (*e.g.*, Leriche) have shown the frequency of thrombosis in the region of the common iliac arteries. Aortography is necessary to visualize this area.

The author has done aortograms on all patients with arterial disease of the lower extremity and found disease of the arterial wall and the common iliac artery with or without obliteration in 35 per cent of his cases. The author gives the history of 3 of these cases with reproduction of several roentgenograms. One case showed a normal aortogram of the femoral artery in spite of a complete obstruction of the common iliac artery on this side. The normal filling of the femoral artery was due to formation of extensive anastomosis.

The author's technique follows Dos Santos' original description with puncture of the aorta at the level of L_3 from the left side and injection of 30 cc. of a 70 per cent iodine compound solution (ioduron or per-abrodil). A roentgenogram is taken during the injection of the last 5 cc. Examinations have been done on ambulatory patients resting one to two hours after examination and no serious after effects have been noticed.

In his summary, the author mentions that aortograms should be done on all cases of suspected vascular pathology within the pelvis or lower extremity.—*E. G. Wissing, M.D.*

WEIS, J. Erfahrungen und Beobachtungen bei 400 Arteriographien. (Experience and observations on the basis of 400 arteriograms.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Aug., 1951, *75*, 145–159.

The author gives a detailed account of techniques used and describes several instructive causes. Injection is carried out by means of an apparatus ensuring constant pressure, usually of 2 atmospheres. Serial roentgenograms are taken. Aortography by injection through the lumbar route under local anesthesia was performed in 29 cases without accident. For aortography, at least 90 cc. of 80 per cent diodone is used and the pressure is increased to $2\frac{1}{2}$–3 atmospheres. The author observed good collateral circulation in cases of occlusion of the common iliac, external iliac and femoral arteries in contradistinction to absence of collaterals with severe trophic disturbances in occlusions of the popliteal artery.

Arteriovenous anastomoses were often demonstrated in cases of increased resistance to the blood circulation in the arteries. The value of arteriography in arterial embolism is stressed. Numerous arteriograms of good quality are reproduced.—*K. E. Matzinger, M.D.*

LEGER, L., ALBOT, G., and ARVAY, N. La phlébographie portale dans l'exploration des affections hépato-spléniques. (Portal phlebography in the exploration of hepatosplenic diseases.) *Presse méd.*, Sept. 15, 1951, *59*, 1230–1232.

In a previous communication (see abstract in this JOURNAL, Oct., 1951, *66*, 677) the authors published their experience with portal phlebography in animals, human cadavers and a few living patients. In the present article they describe the results obtained in various pathologic conditions, especially in the cirrhotic states and Banti's disease.

Briefly, the method consists of injecting 30 to 40 cc. of 50 or 70 per cent diodone solution through a 1–3 mm. caliber polythene catheter into one of the tributaries of the portal vein. Most frequently the right gastro-epiploic vein is chosen, but the injection may also be made into the coronary vein and, in case of exploration of the spleen, into the splenic vein. It is advisable to inject the opaque medium rapidly (within 2 to 3 seconds), preferably with the aid of the Dos Santos apparatus, and to make immediately

roentgenograms of very short exposures. The authors use a portable roentgen unit and bring the tube to within 20 cm. from the patient, thereby obtaining good roentgenograms with and exposure of only 0.3 to 0.5 second. Admittedly, the images obtained by such a technique are distorted at the periphery and somewhat magnified in the center, but this latter is an advantage rather than a disadvantage.

The authors also measure the blood pressure of the portal system. The detailed procedure was described formerly (*Presse méd.*, Nov. 25, 1950, *58*, 1330–1331). Since then the apparatus has been considerably improved and at the same time simplified. At present, the pressure is read directly on the polythene catheter introduced into the portal tributary and held vertically. Several cubic centimeters of heparinized serum, colored with methylene blue, are injected into the upper end of the polythene catheter, being very careful not to introduce any air. This serum prevents coagulation and forms a clearly visible medium for reading the pressure on a sterilized rule. The pressure is expressed in centimeters of water. A pressure of the order of 10 to 20 cm. of water is considered normal, whereas a pressure of from 30 to 70 cm. of water is indicative of portal hypertension.

I. *Normal Portal Phlebography.* With the aforementioned technique, in the normal individual only the main portal trunk and the origins of its terminal branches are visualized clearly. The rapid diffusion of the contact medium into the small venous ramificatons of the liver leads to opacification of this organ in its entirety, hiding the details of the venous pattern. It is hoped, however, that when substances of greater radiopacity become available and the time of exposure is farther reduced a clear demonstration of the intrahepatic branches of the portal vein will also be obtained.

II. *Cirrhoses.* In the presence of partial obstruction, the portal circulation is slowed down considerably, producing a stasis of the dye containing blood which is sufficient to render the intrahepatic branches of the portal vein visible on the roentgenograms. The clearer visualization as compared to the normal is also enhanced by the fact that the venous branches of the third and fourth order are markedly diminished in number and the caliber of the principal branches is definitely reduced in size. These findings confirm the observations made by Holmes and Lovitt in cadaver studies.

III. *Latent Thrombosis of the Portal Vein.* In a patient with an apparent alcoholic cirrhosis, the authors found an enormous development of the collateral circulation associated with a lack of visualization of the main portal trunk. The only explanation they could advance for this is the assumption of a primary pylephlebitis slowly giving rise to an abundant collateral circulation. The cirrhosis of the liver, the presence of which was proved by biopsy, may be a consequence of the portal thrombosis.

IV. *Banti's Disease.* One cause of Banti's disease, as was already demonstrated by the authors and by Santy and Marion in former publications, is the extrahepatic obstruction by portal thrombosis. In such instances the portal phlebogram with injection via the splenic vein shows enormous dilatation of the splenic vein with poor lacunar visualization (due to cavernous thrombus) of the main portal trunk and marked collateral circulation. The authors now present examples of two other possible aspects, one corresponding to intrahepatic obstruction and the other to recanalization of the thrombosed portal trunk or the formation of a collateral canal.

V. *Portal Phlebography by Means of Transparietal Intraparenchymatous Injection of the Spleen.* Abeatici and Campi originated the idea of injecting the contrast material through the abdominal wall directly into the spleen (*Minerva med.*, April 7, 1951, 598). By so doing, they were able to obtain in animals a massive injection of the splenic and portal veins. The authors tried this procedure in 3 human subjects, in 1 during a laparotomy and in 2 by transabdominal puncture of the spleen. The technique of the latter is simple. After local anesthesia a needle is inserted under fluoroscopic control into the parenchyma of the enlarged spleen and with the aid of a syringe 70 per cent diodone is injected. Although there was good opacification of the splenic vein and the main portal trunk in the case in which laparotomy was performed, the injection by the transparietal route failed to produce visualization of the portal trunk. The authors express the opinion that the method of Abeatici and Campi is worthy of further exploration.—*T. Leucutia, M.D.*

General

Hubble, Douglas. Phaeochromocytomata in children. *Arch. Dis. Childhood*, Aug., 1951, *26*, 340–350.

A case of phaeochromocytoma occurring in a $11\frac{1}{2}$ year old boy is reported. Symptoms of acute abdominal pain associated with sweating and tachycardia had been present intermittently for five years and visual disturbances for four years. Physical examination showed scars of old exudates in both fundi, enlargement of the heart in the region of the left ventricle and a blood pressure which varied from 150 to 240 systolic and 100 to 130 diastolic. A positive benzodioxane test suggested the presence of an adrenaline-producing chromaffin tumor. Exploratory laparotomy revealed a tumor in each adrenal area. These were not removed because of the poor condition of the patient. The patient died and necropsy confirmed the presence of a tumor in each adrenal gland and two smaller ones in the paraaortic chromaffin tissue.—*Gerald Lavner, M.D.*

Spring, Maxwell, and Kahn, Sidney. Nonclostridial gas infection in the diabetic; re-

view of the literature and report of three cases. *Arch. Int. Med.*, Sept., 1951, *88*, 373–377.

The purpose of this article is to focus attention upon the fact that gas infections of soft tissues are not necessarily gas gangrene. A historical review and report of 3 cases is presented. It is pointed out that the diabetic patient is a favorable host to these infections, with the combination of infection, high tissue sugar, and impaired circulation.

Recognition of the fact that nonclostridial gas infection may be present does not, however, lessen the need for prompt and accurate diagnosis, in view of the urgency of the situation when clostridial infection is present. Determination of the presence or absence of clostridia is of prime importance. Of secondary importance is the determination of the exact type of nonclostridial infection which may be present.—*D. S. Kellogg, M.D.*

Shechter, Fred R., and Graub, Milton. Löffler's syndrome; report of cases in twins. *J.A.M.A.*, Aug. 11, 1951, *146*, 1420–1422.

These are the first reported cases of Löffler's syndrome in twins. The syndrome is characterized by marked eosinophilia, transitory pulmonary infiltrations, and a paucity of symptoms.

The twins were two years of age. The blood studies and the roentgenograms of the chest in both patients followed the typical course of Löffler's syndrome first described by Löffler in 1932. The findings in each twin occurred simultaneously.

Familial type of eosinophilia was eliminated in this instance by normal blood values in the parents. Periarteritis nodosa was ruled out by the clinical and histological picture. Other causes of eosinophilia, such as various parasitic infestations, brucellosis, skin diseases, and postinfectious convalescence, were eliminated by careful study. Although no causative factor was demonstrated, the authors feel that some unknown allergen was responsible for this condition.

As the lung findings in Löffler's syndrome are variable and can simulate acute and chronic pulmonary tuberculosis, these cases have to be followed for some time with repeated blood counts and roentgen examinations before a definite diagnosis can be established.

The authors include a brief review of the recent literature. The concept of this syndrome has undergone a gradual modification since Löffler's original work.—*E. A. Addington, M.D.*

RADIATION THERAPY

Haagensen, C. D., and Stout, A. P. Carcinoma of the breast. III. Results of treatment, 1935–1942. *Ann. Surg.*, Aug., 1951, *134*, 151–172.

This paper is the sequel to two papers published by the same authors in 1942 and 1943. The first two papers analyzed the results of treatment of carcinoma of the breast at Presbyterian Hospital from 1915 to 1932. Also, criteria of operability were established from the analysis. The present paper is a study of the results of therapy from 1934 to 1942 and a critical analysis of the value of the criteria of operability. This report is of great value to all persons interested in the treatment of carcinoma of the breast and an abstract cannot do justice to the article. The entire report with accompanying charts must be read and studied.

No conclusions were drawn as to the value of preoperative irradiation because of the small number of cases so treated. The authors are of the opinion that postoperative irradiation did not decrease the incidence of local recurrences or increase the five year clinical cure rate. They have discontinued postoperative roentgen therapy except as a palliative measure in patients who had extensive axillary metastasis, and then only the supraclavicular area and anterior mediastinal area were treated.

They employ irradiation for local recurrences and for bone metastasis; in fact, they use up the patient's tolerance for roentgen rays before resorting to hormone treatment.

The authors' criteria for operability remain as stated in 1943, except that carcinoma in pregnant women has been removed from the inoperable class. The curability ratio has increased at the Presbyterian Hospital due to more radical and more thorough operative procedures.—*J. H. Harris, M.D.*

Singh, Bawa P. Primary carcinoma of the vagina. *Cancer*, Sept., 1951, *4*, 1073–1082.

The author reports 21 cases of primary carcinoma of the vagina treated from 1925 through 1949 at Columbia University College of Physicians and Surgeons and the Sloane Hospital for Women. These are studied along with a review of the literature, and a discussion of the lesion as to incidence and etiology is given. The type of lesion most frequently encountered is the everting or papillary form and the most common site of origin is the posterior vaginal wall. The inverting or indurated type is less common and, when present, exhibits a greater tendency to diffuse submucosal and distant spread. Metastasis is usually by lymphatic pathways and spread from a lesion originating in the upper two-thirds of the vagina tends to simulate that of carcinoma of the cervix, while spread from a lesion of the lower one-third is more like that of primary carcinoma of the vulva. All of the carcinomas in this series were epidermoid in type and 75 per cent of these were poorly differentiated.

No one form of treatment was employed and no five year survivals are recorded. Radium therapy was used in 15 cases and 7 of these received additional external roentgen irradiation. The latter group appeared to have a somewhat longer survival and the

longest of these was four years. Radical surgery was employed in 3 patients and 1 of these, who also received external roentgen irradiation, was apparently free of disease eleven months following treatment. The other 2 surgical cases were dead, 1 of coronary occlusion and the other by suicide. One patient received only palliative roentgen therapy and 2 were so far advanced that no treatment was attempted.

A short discussion of radium techniques is given and a method of treatment with adequate doses calculated from an intravaginal tandem is suggested. —*James Martin, M.D.*

Chance, Oliver. Carcinoma of the cervix. *Irish J. M. Sc.*, Sept., 1951, *6*, 406–414.

The author discusses 308 patients suffering from cancer of the cervix uteri seen at St. Anne's hospital, Dublin, between 1938 and 1944. These patients were treated with radium using the Manchester technique, varying the dosage to meet the individual requirements. The results of treatment are given in terms of the fate of these patients five years later. The number of untraced cases is high (62).

Survival rate tables are given showing the net survival, the relative survival and the crude survival; also a method of presenting statistics which calculates from standard death rates for the relevant years the probability of people of various age groups not dying during the follow-up period. The ratio between the patients known to be alive and the total number of patients is divided by the appropriate factor to correct for the death rate due to intercurrent causes. The appropriate factor was compiled by the Director of the Central Statistical Office.

In a discussion as to the relative value of surgery and irradiation in the treatment of carcinoma of the cervix, the author brings up the following factors:

1. All obviously inoperable cases should be treated by radiation therapy. In his group this leaves 35–40 per cent of patients to be considered.
2. In about one-third of these surgery will be contraindicated because of age, poor general condition or cardiovascular disease.
3. Radiation therapy will be contraindicated because acquired or congenital abnormality makes application of radium impossible; where pelvic or adnexal sepsis is present; another pelvic tumor is present which requires surgical removal; disease has recurred after previous radiation therapy and is still operable; patient refuses radiation therapy; pregnancy in which a cesarean hysterectomy is feasible.

This leaves about 20 per cent of patients for controversy. Available statistics favor radiation therapy which carries a negligible mortality and causes little physiological trauma. The author does not approve radiation treatment followed by hysterectomy.—*F. H. Squire, M.D.*

Gusberg, S. B., and Corscaden, J. A. The pathology and treatment of adenocarcinoma of the cervix. *Cancer*, Sept., 1951, *4*, 1066–1072.

A review of 48 cases of definite primary adenocarcinoma of the cervix is presented from the Sloane Hospital for Women in New York. These patients exhibited a slightly higher average age incidence than the average for squamous cell carcinoma of the cervix, but the gross appearance and growth characteristics of the two lesions were identical. Of interest is the fact that the majority of the cases of cervical cancer in Jewish women were adenocarcinoma. Most of the treated patients in this series received radiation therapy and 12 (25 per cent) of these are reported to have survived five years. This may be compared with a five year survival rate from the same clinic of 43 per cent in a much larger group of squamous cell carcinomas of the cervix.

Since this series of cases is statistically small and the follow-up periods short, the authors attempted to evaluate the radiosensitivity of these lesions by observing early response of the primary growth to irradiation in 38 of the cases. No significant difference was observed in these instances as compared to the response of squamous cell carcinoma and it is suggested that treatment of both lesions should be planned on the basis of similar principles of growth, extension and sensitivity.—*James Martin, M.D.*

Wheelock, Frank C., Fennell, Robert H., Jr., and Meigs, Joe V. Carcinoma of the ovary; clinical and pathological evaluation. *New England J. Med.*, Sept. 20, 1951, *245*, 447–449.

The authors review 67 patients with primary malignant ovarian disease seen between 1935 and 1943. These patients were treated for the most part by surgical exploration and removal of tumor whenever possible, followed by deep roentgen therapy in various amounts.

Of these patients, 28.4 per cent lived five years after the diagnosis was established. This group was found to be 11 per cent superior to a similar group reported previously from the same institution.

The authors emphasize that proper therapy consists of surgical removal of tumor, the other ovary, both tubes and the uterus, including the cervix whenever possible. Roentgen therapy is definitely indicated if the tumor has been incompletely removed, and was used in a great many cases in which surgical removal was judged to be complete. It was possible to correlate histopathologic appearance of the tumor with the survival rate, as the better differentiated tumors were found to be slower growing.—*C. L. Hinkel, M.D.*

Auerbach, Oscar; Friedman, Milton; Weiss, Leo; and Amory, Harold I. Extraskeletal osteogenic sarcoma arising in irradiated tissue. *Cancer*, Sept., 1951, *4*, 1095–1106.

The authors have reported in careful detail an unusual case of apparent malignant degeneration in heavily irradiated tissue in a young man. Treatment was given to each of five portals following surgical treatment for a testicular seminoma. Each field received a total skin dose of 4,000 r (in air with scatter) in increments of 400 r delivered over a total period of seventy days. Treatment factors were: 200 kv., 0.5 mm. Cu and 1.0 Al filter, 1.0 mm Cu half-value layer; and 50 cm. T.S.D.A. 10 by 15 cm. field over the lower dorsal spine exhibited more marked changes in the skin than the other areas. At first the pigmentation was somewhat deeper and later, atrophy, depigmentation and telangiectasia were more pronounced. Four years after the completion of treatment the patient developed symptoms of back pain, and examination revealed the first evidence of a rapidly growing soft tissue osteogenic tumor beneath the treatment field, and apparently not arising from adjacent bone structures. Rapid growth and metastasis characterized the lesion and led to the patient's death three years later, in spite of attempts at surgical removal.

This case probably represents the only reported instance of such a tumor arising in irradiated tissue. Several theories regarding histogenesis of this lesion are discussed.—*James Martin, M.D.*

Spitz, Sophie, and Higinbotham, Norman I. Osteogenic sarcoma following prophylactic roentgen-ray therapy; report of a case. *Cancer*, Sept., 1951, *4*, 1107–1112.

The case of a forty-six year old male, who developed osteogenic sarcoma of the lumbar spine four years after heavy prophylactic irradiation, is reported from the Memorial Hospital, New York. Treatment had been given over a period of about three months with 1,000 kv. equipment, following surgical removal of a testicular seminoma. Each of five fields directed toward the retroperitoneal space received 4,900 r in air, and calculated depth doses at the spine ranged from 3,281 r to 5,289 r. Although the patient developed a gangrenous appendix during the course of therapy there was nothing clinically or at subsequent autopsy which suggested radiation damage to the bowel. The authors feel that the radiation therapy was the cause of this patient's sarcoma and subsequent death, and suggest that palliation with such large doses is unjustified, particularly in the instance of seminoma, which will respond to considerably less irradiation.—*James Martin, M.D.*

RADIOISOTOPES

Mitchell, Joseph S. Practical aspects of radioactive isotopes in relation to medical treatment. *Brit. M. J.*, Sept. 29, 1951, *1*, 747–757.

This is an excellent general article dealing with the practical aspects of radioactive isotopes as applied to medical treatment.

The radioactive isotopes of interest in medical treatment are listed in a table. They fall into three main groups: (1) those administered internally, (2) those used as gamma-ray sources, and (3) those used as external beta-ray sources. Each of these three main groups is surveyed, and the use of the more important individual isotopes is discussed in detail.

(1) As regards the internal administration of radioactive iodine, the author states that in England "it has been thought wise to proceed rather cautiously, mainly because of concern over the possibility of the development of malignant changes, perhaps many years after the administration of the radio-iodine. While it is recognized that this risk is small and subsequently may be shown to be negligible, it is considered that at present more evidence is required, and that there is no justification for abandoning lines of treatment of proved value in favor of radioiodine therapy. It is recommended as a general principle that in the treatment of thyrotoxicosis radioiodine should not be given to patients of either sex under the age of forty-five unless other methods of treatment have failed or are contraindicated."

In carcinoma of the thyroid radioiodine is of value in only a small proportion of cases, probably in about 10 per cent. For the other cases, surgery continues to be the most important treatment, and roentgen therapy is still very useful.

In reference to radiophosphorus, the author expresses the opinion that the only disease in which treatment with this isotope has given consistently better results than roentgen therapy is polycythemia vera.

He also warns against the internal administration of other radioactive substances in patients under forty-five with nonmalignant conditions, or in patients with cancer or allied diseases in whom the expectation of life exceeds five years. He stresses that it is essential to first "assess quantitatively the risk of late carcinogenesis for comparison with the risks associated with other forms of treatment, including surgery."

(2) The author is in agreement with those who believe in the practicality of the use of artificial gamma-ray emitting isotopes as substitutes for radium. He believes radiocobalt to be satisfactory for interstitial and intracavity application and for use in external applicators and moulds. However, he thinks radiocobalt has yet to be proved as a practical source in large teletherapy units. On the other hand, the author is confident of the value of radioiridium as a gamma-ray source in teletherapy. He installed

such a unit at the University of Cambridge. The plan of the installation is shown diagrammatically and the calculated dose distribution for a patient with carcinoma of the larynx is presented. Also shown are three photographs of patients (2 patients with intrinsic carcinoma of larynx: 1 patient with carcinoma of the posterior third of the tongue) being treated with this unit.

It is assumed that the biologically equivalent dose of radioiridium gamma radiation is 1.2 times the dose of filtered 220 kv. roentgen radiation under comparable conditions and that for practical purposes the radioiridium teletherapy unit is equivalent to a standard radium beam unit.

(3) The author thinks that the view widely held at one time that beta rays of radium were caustic in their effects was due to gross overdosage. The therapeutic use of beta rays has suffered for more than twenty years because of the absence of accurate dosimetry and planned dosage distribution in the case of the classical beta-ray plaque. Recently, however, appreciable progress has been made towards solving these problems; at the same time, surface applicators utilizing the beta rays of radiophosphorus were made available. The most valuable use of P^{32} beta-ray applicators so far appears to be in the treatment of selected cases of cavernous angioma in infants and young children.

The author concludes by recommending a very conservative approach to the therapeutic problem of radioactive isotopes, for at the present time their use "seems to be of considerable value in a few very limited fields of practical medical treatment."—*R. F. Niehaus, M.D.*

Selverstone, Bertram, and White, James C. Evaluation of the radioactive mapping technic in the surgery of brain tumors. *Ann. Surg.*, Sept., 1951, *134*, 387–396.

Effective surgical attack upon an intracranial tumor requires a craniotomy planned with considerable precision. Ventriculography, electroencephalography, cerebral angiography and methods employing radioactive isotopes have provided data useful for this purpose. This paper deals with the use of the latter procedure.

The second phase of localization of a cerebral tumor, after the dura has been opened, is frequently unsatisfactory by visualization and palpation alone, and it is in this phase that the use of isotopes is very helpful.

Attention is called to previous reports showing the strikingly greater uptake of radioactive phosphorus (P^{32}) and of radioactive potassium (K^{42}) in cerebral tumors as compared to normal brain. This finding, together with development of the 2 mm. probing Geiger-Müller counter, has made possible the localization and demarcation of cerebral tumors with considerable precision.

The procedure has been used in 150 cases of cerebral tumors of virtually all histopathological types: in 114 cases with P^{32} and in 36 cases with K^{42}. The authors give tables summarizing their experiences. In the 114 cases where P^{32} was employed there were 108 correct localizations, 1 uncertain localization, 4 falsely negative studies, and 1 falsely positive study In 5 of these cases there was no tumor found and subsequent course confirmed this observation. In the 36 cases in which K^{42} was employed, there was correct localization in 35 cases, 1 falsely negative study, and 0 falsely positive studies.

P^{32} emits only beta particles which penetrate about 7 mm. of brain tissue. K^{42} emits more energetic beta particles penetrating up to 1.8 cm., and also some gamma rays, the type of counter used being relatively nonsensitive to the latter. In view of this difference, the localization with P^{32} is more accurate. The half-life of P^{32} is 14.3 days, while that of K^{42} is only 12.44 hours. From this standpoint P^{32} is more practical. However, K^{42} provides useful ratios between tumor and brain within a few minutes after injection, while P^{32} requires an interval of about twelve hours. Each reading can be obtained within a few seconds and therefore does not significantly prolong the operation.

The procedure is useful not only for localization of the brain tumor, but also for its demarcation. It enables the surgeon to obtain a valid biopsy and thus to decide in advance whether the extent of a neoplasm makes it inoperable. The face of a resected area may be scanned to demonstrate if all tumor has been removed. In some cases, a simple trephination with the use of this method may prevent an unnecessary craniotomy.

The authors include several photographs and diagrams from autopsy material to demonstrate the procedure more clearly.—*I. E. Holmes, M.D.*

Kurland, George S., and Freedberg, A. Stone; with the technical assistance of Mary J. McManus. The distribution of I^{131} in tissue obtained at necropsy or at surgical operation in man. *J. Clin. Endocrinol.*, Aug., 1951, *11*, 843–856.

Radioactive iodine is being used extensively in the diagnosis and treatment of thyrotoxicosis and carcinoma of the thyroid. It has also been used to induce myxedema in euthyroid patients with intractable angina pectoris and congestive heart failure. The biologic effects of radioactive iodine depend largely upon the emission of beta rays. Since the range in tissue of these rays is only approximately 2 mm., the concentration of I^{131} within any organ determines in large measure the amount of radiation to that organ. The interaction of gamma rays from I^{131} contributes a relatively small per cent of the irradiation effect at any one point.

Despite the wide clinical use of radioactive iodine, data on the distribution of I^{131} in man and, consequently, on the radiation delivered to the thyroid and other organs is scanty. For this reason this study was made.

The distribution of I^{131} was studied in 13 patients. Seven of the patients with normal thyroids were given 300–850 microcuries of carrier-free I^{131} from four to 168 hours before orchidectomy or oophorectomy. In the remaining 6 patients a dose of 1.7 to 39.1 millicuries was administered from one to eighty days before death. The data indicate that the major portion of the radiation was delivered to the thyroid gland. Other organs received only a small fraction of the radiation delivered to the thyroid, 1 per cent or less. In most instances the organs, in order of decreasing I^{131} uptake per gram of tissue, were lung, kidney, pituitary, liver, gonad, spleen, adrenal and pancreas. These data indicating the small amount of radiation delivered to organs other than the thyroid gland are consistent with the authors' clinical experience in 215 patients treated with total doses of I^{131} of from 1.7 to 209 millicuries. Evidence of immediate injury to the bone marrow, kidney, liver or gonads has not been found following doses of this magnitude.—*F. J. Rigos, M.D.*

Kearns, John E., and Hutson, William F. The use of radioactive iodine studies in congenital thyroid aplasia; differentiation between the mongoloid and cretinoid child at birth. *Quart. Bull., Northwestern Univ. M. School*, Fall, 1951, *25*, 270–272.

It is of great importance to differentiate between the cretinoid and mongoloid child as early as possible because with adequate substitution therapy throughout life the prognosis is good in cretinism which is due to congenital thyroid aplasia. Satisfactory therapy is not available for the mongoloid child owing to lack of an effective pituitary hormone. Congenital hypopituitarism is thought by some to be the etiological factor in this disease.

The problem of accurately differentiating between mongoloid and cretinoid children at birth and in early infancy has been very difficult in the past as the physical characteristics often overlap. Roentgen studies offer some help in that the cretin shows a delay in appearance of the ossification centers in the carpal bones, although this may also be present to a lesser degree in the mongoloid child. The mongoloid child may have a rudimentary middle phalanx of the little finger and extra epiphyseal centers in the first and second metacarpals.

The authors' use of radioactive iodine as an aid in the differential diagnosis of these two conditions began in 1948. The patients studied varied in age from a few days to two years. The radioactive iodine was given in a small feeding or in sugar water. The average dose administered was 0.1, or less, of a millicurie. The thyroid uptake was determined by external survey, urinary assay and conversion ratio of the radioactive iodine. The serum protein-bound iodine was also measured.

A comparison between normal, mongoloid and cretinoid infants showed that the normal and mongoloid infants had the same values, whereas in the cretinoid infant there was only slight activity over the thyroid gland, the conversion ratio and the serum protein-bound iodine were much lower, and the per cent of the dose excreted in the urine was higher.

The authors include a chart showing the comparative values they obtained with their technique in a normal infant, a cretinoid infant and a mongoloid infant.—*C. W. Cooley, M.D.*

Godwin, John T., Duffy, B. J., Jr., Fitzgerald, Patrick J., Trunnell, J. B., and Rawson, Rulon W. Pathological effects and radioautographic localization of I^{131} in humans; postmortem study in nine patients. *Cancer*, Sept., 1951, *4*, 936–950.

Postmortem study was done in 9 patients, 6 female and 3 male, ranging in ages from thirty-seven to eighty years. Seven had carcinoma of the thyroid; 1, an intrathoracic goiter; and the other, a renal carcinoma with generalized metastasis.

In all cases, I^{131} was given in anticipation of postmortem studies. The dose varied from 1.91 to 250.0 mc. with the interval between administration and death ranging from eight hours to thirty-five days. The I^{131} was administered orally except in 2 instances.

Extensive laboratory examinations were done in most cases and, at autopsy, 3 individual sets of tissues were taken if size of the specimen allowed. One set was used for routine paraffin sections; 1, for direct measurement of radioactivity by the Geiger-Müller counter; and the third, for radioautographic studies.

Detailed case studies are presented and readers interested in the problem of the distribution and effects of radioactive iodine are referred to the text of this very interesting paper. Adequate presentation of the findings cannot be done in summary form.

Histopathologic changes due to I^{131} were seen in primary thyroid tumors and some metastatic lesions. The distribution of radioiodine in both primary and metastatic lesions was in agreement with previous reports for comparable histologic types. Other organs examined by radioautography showed no significant pickup of I^{131}.

There was striking variation in pickup of tumors of similar histopathologic types. Histopathologic changes attributable to I^{131} showed similar variation. Of interest was the localization of radioiodine in areas of necrosis and fibrosis in which there were few tumor cells.

One patient developed an aplastic anemia at-

tributed to I^{131}, following a total dose of 638 mc. In another patient receiving a total dose of 820 mc. of I^{131}, there was no histological change in the remaining noncancerous thyroid tissue. In a few instances, metaplasia and chronic inflammation of the trachea were present.

The authors believe that the therapeutic effectiveness of I^{131} in thyroid carcinoma is limited. In part, its value depends upon the histopathologic type of the tumor and even with very high doses of I^{131} complete regression cannot be demonstrated. Pathologic and radioautographic studies have shown viable tumor cells in all cases even in the presence of I^{131} pickup.—*Robert Emerick, M.D.*

Speert, Harold, Quimby, Edith H., and Werner, Sidney C. Radioiodine uptake by the fetal mouse thyroid and resultant effects in later life. *Surg., Gynec. & Obst.*, Aug., 1951, *93*, 230–242.

Pregnant mice were injected with single doses of radioiodine at various stages of pregnancy. The radioactivity in the fetus was measured forty-eight hours later. The following results were noted:

(1) Iodine concentration in the fetus occurred in animals injected on the sixteenth day of pregnancy but not earlier.

(2) This corresponds with the stage of development at which follicles begin to appear in the fetal thyroid.

(3) The rate of uptake of I^{131} increased rapidly as term was approached.

(4) Later reproductive performance was normal in the male offspring, possibly impaired in the female offspring, of the I^{131} treated mothers.

(5) Specific pathological changes occurred in the thyroids of the offspring. These changes consisted of fibrosis, later compensatory hyperplasia with adenoma formation, and ultimately, colloid goiters.

(6) Chromophobe adenomas of the pituitary were discovered in one-third of the surviving offspring between the ages of nine and twelve months.

(7) The use of radioiodine in the treatment of pregnant human patients after the first trimester is considered unwise in the light of present knowledge, if the therapeutic objective can be attained by other methods of treatment.—*Mary Frances Vastine, M.D.*

Diamond, Henry D., and Craver, Lloyd F. Radioactive phosphorus. II. In the treatment of myeloid leukemia. *Cancer*, Sept., 1951, *4*, 999–1008.

Over a ten year period, 77 patients suffering from myeloid leukemia were treated with radioactive phosphorus (P^{32}). The original indications for treatment were absence of a hypoplastic bone marrow and a peripheral leukopenic blood status.

Of 59 chronic cases, only 9 patients were treated exclusively with P^{32}. Other methods used in ancillary treatment were locally applied high voltage roentgen rays, total body irradiation, Fowler's solution, urethane, folic acid antagonists, nitrogen mustard and its congeners and, in 1 instance, the radium element pack.

Ten of the 18 acute cases received P^{32} only. Local roentgen therapy, Fowler's solution, folic acid antagonists, or nitrogen mustard congeners were used in treatment of the remaining 8 cases, as well as P^{32}.

All patients received P^{32} orally. In chronic cases the total dose of P^{32} was approximately 0.1 mc. per kg. of body weight, given as daily doses of 1.0 mc. until the total was reached. In acute cases the dosage was below the level of 0.1 mc. per kg. of body weight but exact dosage was not mentioned.

Another course of P^{32} was given when indicated clinically and when the hemogram and bone marrow indicated a return of active proliferation.

Criteria of good response to P^{32} therapy were rise in hemoglobin or erythrocyte levels, fall in total blood cells and shift of differential toward normality and decrease in splenohepatomegaly.

Treatment of acute cases by radioactive phosphorus gave no beneficial results. The average survival time of the chronic cases, measured from time of onset of the disease, agreed with figures published previously by other investigators. P^{32} produced in 95 per cent of the chronic cases at least a transitory fall in the peripheral white blood cell count. In approximately 50 per cent, the hemoglobin and red blood cell count either showed no significant change or rises in their levels. When decrease in splenomegaly occurred, it was transient so that local roentgen therapy was given for enlarged spleens.

The authors conclude that P^{32} is of value in palliation of chronic myeloid leukemia when used in conjunction with other known modalities of treatment. —*Robert Emerick, M.D.*

Skipper, Howard, E., Bennett, Leonard L., Jr., and Langham, Wright H. Over-all tracer studies with C^{14}-labeled nitrogen mustard in normal and leukemic mice. *Cancer*, Sept., 1951, *4*, 1025–1027.

In order to study the mechanism of carcinocidal activity of nitrogen mustard, this compound was labeled with radioactive carbon (C^{14}). Studies following the injection of tagged nitrogen mustard in normal mice showed the radioactive carbon distributed throughout all organs and tissues with higher concentration in the blood serum than in the cells. The small intestine was consistently most active. The bone marrow was one of the lowest activity tissues.

Comparison of normal and leukemic mice showed a preferential fixation of the radioactive carbon in lymph nodes, adrenals, thymus and brain of the leukemic animals. The activity of urine samples of

the leukemic mice was higher than that of the controls.—*Robert Emerick, M.D.*

CHEMOTHERAPY

Roswit, Bernard, and Kaplan, Gustave. Nitrogen mustard as an adjunct to radiation in the management of bronchogenic cancer. *Radiology*, Sept., 1951, *57*, 384–394.

Although surgery with pulmonary resection offers the patient with bronchogenic carcinoma the best chance for cure, too many patients present themselves for treatment when the disease is already inoperable. To these inoperable patients whose life expectancy is most certainly less than one year, the chance for a longer useful life, from many months to even years, and one that is pain free and more comfortable can be offered by giving roentgen treatment. Unfortunately, however, not all inoperable patients are in a physical condition satisfactory enough to withstand the irradiation. Because of this, effective adjuncts to roentgen therapy were sought and nitrogen mustard (HN_2)—methyl-bis (beta chlorethyl) amine hydrochloride—was used by these authors.

Nitrogen mustard is a systemic toxin with special selectivity for the blood-forming organs, the gastrointestinal tract, and actively proliferating tissues. Since its action is remarkably rapid and its physical half-life only 90 seconds, the lungs receive the full impact after intravenous injection, and in that way give the actively proliferating tissues of the tumor the maximum effect.

In this study, 150 patients with inoperable bronchogenic carcinoma were treated with irradiation. Of this group, 40 received HN_2 as an adjunct to the roentgen therapy for the following reasons: (a) radioresistance, (b) severe radiation sickness, (c) exhaustion of the skin portals, (d) intractable systemic symptoms, (e) acute mediastinal compression, and (f) far advanced disease with generalized metastases. The nitrogen mustard was given intravenously in doses of 0.1 mg. per kilogram of body weight, once daily for four consecutive days. This constituted one course, and a second one was given if indicated after a period of four weeks or longer to permit the bone marrow to recover. Roentgen therapy and nitrogen mustard were not employed simultaneously and no more than two courses were given.

Eight case histories are described giving the indications and results. Of the 40 patients who received nitrogen mustard as a systemic adjunct to roentgen therapy, 30 had remission of severe subjective symptoms and 19 experienced objective improvement. These remissions ranged from one to seventeen weeks, with an average of three and a half weeks. In several patients it became possible to initiate effective roentgen therapy after a single course. The literature reveals that a total of 254 cases have been treated with HN_2 by 14 other investigative groups and that 134 of these cases (52.8 per cent) had a favorable response. The authors stress, however, that nitrogen mustard should never be employed as a substitute for roentgen therapy in the presence of relatively localized inoperable bronchial cancer and state that such patients should be given the benefits which local cancerocidal radiation can offer.—*D. N. Dysart, M.D.*

Brandt, Eugenia L., and Griffin, A. Clark. Reduction of toxicity of nitrogen mustards by cysteine. *Cancer*, Sept., 1951, *4*, 1030–1035.

The value of nitrogen mustards has been limited by their toxicity. Experimental studies have shown that in vitro 4 to 10 times a lethal dose is necessary to kill leukemic cells. Rat sarcoma 180 is destroyed in vitro by from 10 to 14 times LD_{50}.

Clinical and experimental attempts to reduce toxicity have been successful by deriving maximum effect of the drug in regional therapy, *i.e.*, by limiting the drug to areas involved by intra-arterial injection, by temporarily isolating the vascular area treated and by excluding those areas where vascular interruption is feasible, such as uninvolved limbs. Another method of reducing toxicity is suggested by the protective effect of cysteine in roentgen exposure since the action of nitrogen mustard is in many ways similar. This protective effect apparently is the result of replacement of the sulfhydryl group, the level of which is lowered by both roentgen rays and nitrogen mustards.

Using rats and mice, the authors obtained good protection to doses of nitrogen mustard of from 2 to 3 times LD_{50} when cysteine was given before the mustard. The protection was complete when the cysteine was given (intraperitoneally) from forty-five to fifteen minutes before the mustard, less so when it was given shortly before or after the mustard, and valueless when it was given thirty minutes after the mustard. This protection was effective for both HN_2 and HN_3. Other compounds containing sulfhydryl groups, sulfur or reducing agents were not protective.

To investigate the possibility that nitrogen mustard was inactivated by cysteine, two of the mustard's properties were observed. The leukopenic action of the mustard was found to be unaffected and the appearance of tumors in some of the mice indicated that its carcinogenic property was not diminished.—*H. J. Klos, M.D.*

MISCELLANEOUS

Bennett, L. R., Rekers P. E., and Howland, J. W. Influence of infection on the hematological effects and mortality following midlethal roentgen irradiation. *Radiology*, July, 1951, *57*, 99–103.

This study was undertaken to determine the in-

fluence of infection on the hematological effects and mortality following mid-lethal roentgen irradiation. Blood studies were done on 54 dogs receiving whole body irradiation with doses of 350 r to 450 r. Complete hematological studies were performed prior to irradiation and three times weekly following irradiation. Bacteriological studies were carried out at the same time.

In the entire series of 54 dogs, 32 died. All animals dying after the eighteenth day showed positive blood cultures. Evidence indicates that, in the two weeks immediately following irradiation, death may occur solely as a result of the primary toxic effects of the radiation. After two weeks, infection alone or combined with hemorrhage plays a more dominant role in radiation mortality.

A direct correlation was found to exist between depression of the leukocyte count and mortality, but no direct correlation could be made between the leukopenia and the infection of dying animals.

Fall in erythrocyte count, present in all animals following irradiation, was most marked in animals dying with positive blood cultures. Besides the inhibition of red cell production following general body irradiation, an added hemolysis may contribute to the decrease in the number of circulating red cells. This may be due partially to hemolysis by bacterial infection.—*A. W. Sommer, M.D.*

Wilson, C. W. Dependence of the human skin reaction produced by ionizing radiation upon the type of radiation; some speculations. *Radiology*, July, 1951, *57*, 83–89.

The author presents some of his speculations concerning the variation of the skin reaction with ionizing radiations of different types by assuming that the basic cause is due to induced chromosome abnormalities arising from chromosome or chromatid breakage. He leans heavily on the work of Lea and Catcheside on the effect of ionizing radiation on the chromosomes of *Tradescantia*. These investigators have shown that the number of chromatid breaks depends upon the number of ionizing particles and their ion density (ions per micron of path). The author approaches this problem from the point of view of the number of effective particles, more particularly of the effective path lengths of the particles in terms of their ability to produce chromosome breakage.

The author's study is mathematical. On the basis of the observations of Lea and Catcheside on *Tradescantia*, he calculated a theoretical curve expressing the dependence of the number of chromatid breaks upon roentgen-ray wavelength. This curve was then compared with the graph of Trump showing the variation of the threshold erythema dose in r with voltages over a potential range of about 100 to 3,000 kv. An approximately similar trend was found.

The author also applied his theoretical considerations to the chromatid breakage as an index of the biologic effect produced by neutrons and fast protons. As regards the neutrons, the calculated data indicated that the higher the energy of the neutron beam, the lower is its efficiency in the production of this type of biological effect. Thus the observations made by Stone concerning the decrease of the skin reaction with increase in neutron energy were confirmed. These findings suggest that, when equipment is made available yielding fast protons of energy up to 125 mev. and more, the ionization dose of such protons required to produce a skin erythema might possibly be much greater than that so far observed for beams of neutrons.

The author feels that while these speculations do not prove that the human skin reaction has its basic cause in the production of chromosome abnormalities, they are not inconsistent with it.

It is recommended that those interested in the author's calculations read the original article.—*Dean Nichols, M.D.*

Handloser, John S., and Love, Robert A. Radiation doses from diagnostic x-ray studies. *Radiology*, Aug., 1951, *57*, 252–254.

Workers at the Brookhaven National Laboratory are exposed to radiation both from radioactive materials and conventional diagnostic roentgen equipment. In order to be certain that total body irradiation did not exceed 0.3 r per week, an investigation of the roentgen output of their diagnostic equipment was made. A phantom and a Victoreen condenser r meter corrected for soft roentgen rays after the method of F. Day were used to determine the dosage rates. These data are tabulated in two graphs which are used to determine roentgen exposure to the part during diagnostic examination.—*M. B. Goodwin, M.D.*

Hutchinson, Franklin. The determination of tissue dosage. *Radiology*, Aug., 1951, *57*, 234–239.

Knowledge of the dose at every point throughout the treated tissue is the basis for any rational scheme of roentgen therapy. This paper reviews the data and methods available to make such dosage assessments.

It is concluded that the most reliable set of depth dose data is that of Quimby and Braestrup. Doses at points off the axis may be calculated by the method devised by Meredith and Neary. This is an approximate method for evaluation of the dose at any point in the radiation field. The values of the parameters involved are calculated from the axial depth doses for circular fields of different areas. It is concluded that the numerical values of the parameters used by Meredith and Neary need to be changed to make them agree with the Quimby-Braestrup data.

An approximate way of making the correction is

first to calculate an off-axis dose as a percentage of the dose in the center of the field at the same depth. The actual dose at the desired point is then found by taking this percentage of the axis dose given in the Quimby-Braestrup tables. It is thus possible to calculate with reasonable accuracy the dosage in any part of a radiation field.—*A. W. Sommer, M.D.*

Hare, Hugh F., Lippincott, Saumel W., Jr., Sawyer, David, Trump, John G., Webster, Edward W., Wright, Kenneth A., Evans, Winfield W., and Granke, Richard C. Physical and clinical aspects of supervoltage rotational therapy. *Radiology*, Aug., 1951, *57*, 157–168.

The authors discuss the physical and clinical aspects of 2 million volt roentgen therapy by rotational administration, with particular reference to the treatment of tumors of the head and neck.

Higher voltages improve the quality of penetration, the freedom from scatter and the skin tolerance at the portal of entry. The authors selected 2 million volt roentgen rays because of certain fundamental and practical considerations.

1. Roentgen rays produced at 2 million volts attain most of the desired physical properties of increased depth dose, high output intensity, uniform field illumination, and minimum beam scatter. These various properties are discussed in detail and demonstrated with a 2 million volt isodose curve.

2. Skin tolerance has reached a satisfactory high level at 2 million volts. The skin tolerance is substantially higher than for 1 million volt radiation. Above the 2 to 5 million volt range the exit skin reaction increases rapidly.

3. The ratio of bone to soft tissue absorption is low at 2 million volts. Radiation produced at conventional voltages or by many millions of volts shows preferential absorption in bone and cartilage.

4. Considering cost, size and complexity of voltage sources, the authors found the Van de Graaff electrostatic generator to have advantages in smaller size, its freedom from auxiliary apparatus and its small target spot.

5. Two million volt radiation can be controlled with reasonable facility. Sharply defined fields of all sizes and shapes can be produced. The quality of 2 million volt radiation is identical to that of gamma rays of radium. The beam intensity of the electrostatic 2 million volt roentgen source is 300 r per minute at 50 cm., which corresponds to that of 5,000 gm. of radium.

The technique of rotational roentgen therapy through a horizontal plane is described. Lateral double-exposure roentgenograms are made for proving the positioning of the patient. Total tumor doses of 4,000 r to the pituitary, 6,000 r to the larynx and 6,000 r to pelvic tumors can be given with little skin reaction.

Total body dose would, in all the above treated cases, be larger if less penetrating radiation were used, and the delivered tumor dose would be less uniformly distributed.

Tumors of the brain, nasopharynx, tonsil and metastases to cervical lymph nodes have also been treated by the above method. Occasionally only sectional rotation or opposing lateral and anteroposterior fields must be employed to avoid radiosensitive regions.

At present the plan is to deliver 6,000 r to all malignant growths. If the lesion can be included in a port 5 cm. in diameter a tumor dose of 240 r is given daily for twenty-five days. If the port must be larger than 5 cm. in diameter the tumor dose is reduced to 170 r per day for thirty-five days.

The clinical results are discussed mainly in terms of palliation and the desirable features of 2 million volt radiation over conventional radiation are presented.—*E. E. Seedorf, M.D.*

Stephenson, B. R., and Eschner, E. G. Impulse counter for checking x-ray timers. *Radiology*, July, 1951, *57*, 104–105.

The authors describe an impulse counter of relatively simple construction. With this counter an immediate check of the accuracy of the timers used for short roentgen exposures can be made without resorting to the spinning top method.

A message register (Western Electric, Type 14 E) is connected in series with a half-wave selenium rectifier. A second register is connected to another reictfier in the same way. These two units are connected in parallel so that each bears a polarity opposite to the other permitting half cycles to be registered. The total of both counts will give the total number of impulses for a given time interval.

The counter is connected to the terminals of the primary coil of the high tension transformer. The total counts should be identical with the number of dots made with a spinning top which is used to check the accuracy of the impulse counter.—*E. M. Cooper, M.D.*

Bloor, Byron M., Wrenn, Frank R., Jr. and Hayes, George J. An experimental method for the evaluation of contrast media used in cerebral angiography. *J. Neurosurg.*, July, 1951, *8*, 435–440.

Data have now been published with evidence of pathologic changes in the brain following the diagnostic use of contrast media for cerebral angiography. Certain dyes will permeate damaged vascular endothelium while sparing unaltered vessels. In this study the tetrasulfonic acid of copper phthalocyanine was injected with contrast medium into the common carotid artery of rabbits while electroencephalographic tracings were made. There was definite correlation of electroencephalographic changes and tis-

sue staining by the contrast medium. The method shows promise.—*E. C. Baker, M.D.*

Smith, Falconer, and Grenan, Marie M. Effect of hibernation upon survival time following whole-body irradiation in the marmot (marmota monax). *Science*, June 15, 1951, *113*, 686–688.

The relationship between reduced body temperature, lowered metabolism and rate of development of the toxic effects of radiation in the marmot is studied by the authors. Marmots were selected because the metabolic rate in the hibernating marmot averages only about one-third that found in the non-hibernator. Two groups of marmots equally matched as to age and sex were irradiated. One group was allowed to hibernate at 3°C. and 650–800 r was given three weeks after the onset of hibernation. The other group was maintained at room temperature and was given 550 r, serving as control.

Irradiation was carried out with a 200 kv. (peak) unit; one-half the dose was applied to each side of the animals. Marmots completing 28–42 days of hibernation after 650 r survived 40–54 days compared with a survival time of only 18–27 days for the non-hibernator controls given 550 r. Increases in the length of hibernation time after irradiation did not result in corresponding increases in post-hibernation survival time.

Weight loss in the hibernating marmot averaged 5.6 grams per day following irradiation, compared with an average weight loss of 9.2 grams per day after irradiation in the non-hibernators. The blood picture was unchanged in the irradiated hibernators during hibernation but after their return to room temperature both erythrocyte and leukocyte concentrations fell rapidly.

This study indicates that there is a delay in the lethal process from irradiation in the marmot when body temperature is lowered; however, no great decrease in sensitivity to irradiation is apparent.—*W. M. Roy, M.D.*

Chase, Herman B. Number of entities inactivated by x-rays in greying of hair. *Science*, June 22, 1951, *113*, 714–716.

The author made observations on the greying of the hair of rabbits by roentgen rays. He found that it required a threshold of about 900 roentgens and that the effect was permanent. The effect was greater when the telogen (resting) areas than when the anagen (actively growing) areas were irradiated.

The author believes that the roentgen rays destroy the "reservoir" of pigmentary dendritic cells. It is presumed that these cells supply the matrix cells with basic pigment granules by a cytocrine function. In the matrix cells there is further development of melanin. On section the melanogenic dendritic cells may be seen; usually one being in contact with several matrix cells.

On analysis of the greying response as a dose response, survival curves were determined using 100 kv. and an intensity of 550 r/min.: one on inactive (telogen) follicles, the other on active (anagen) follicles. The results of this analysis indicated that inactive follicles have about three entities to be inactivated whereas the active follicles have approximately six to twelve such entities. The theoretical curves demonstrated why anagen follicles are less sensitive; why larger follicles are less sensitive; and why with larger follicles there is less difference between treated follicles in the anagen or telogen state.

The author concludes that all white hairs are the result of a complete inactivation of the dendritic cells. Mosaics (partially pigmented) are the result of a complete inactivation of some and a partial inactivation of other dendritic cells. The basic pigment sites in the matrix cells are of extrinsic origin, specifically from a small reservoir of pigmented dendritic cells.—*R. A. Hays, M. D.*

Carlson, Ralph F., Charbon, Bernard C., Charbon, Harmia G. A., and Adams, W. E. The effect of decreasing the amount of lung tissue on the right ventricular pressures in animals. *J. Thoracic Surg.*, June, 1951, *21*, 621–632.

Most patients are able to tolerate a pneumonectomy with surprisingly few obvious circulatory changes, but a certain number—notably those in the older age group—are not able to tolerate pneumonectomy. In some cases this may be due to the failure of the right ventricle to make a satisfactory adjustment to the strain of having the pulmonary vascular bed suddenly reduced by 50 per cent.

It was thought, therefore, that it would be of interest to study the right ventricular pressures in a controlled animal experiment during and after the romoval, in stages, of up to 85 per cent of the pulmonary tissue by a combination of pneumonectomy and lobectomy. A detailed discussion of the technique used is given.

In the majority of animals decreasing the pulmonary tissue caused a rise in the right ventricular systolic pressure somewhat in proportion to the amount removed. Many dogs tolerated removal of all but the right middle and upper lobes. Very few were able to tolerate removal of all but the left upper lobe.

It was difficult to correlate right ventricular pressure changes with the survival or death of the animal. The right ventricle in dogs has considerable power of compensation, providing the stress is imposed gradually.—*T. C. Stansbury, Jr., M.D*

Cornil, Lucien, and Stahl, André. Essai d'interprétation histochimique de la radiosensibilité des tissus normaux et néo-pla-

siques. Rôle des acides nucléiques. (A histochemical interpretation of the radiosensitivity of normal and neoplastic tissue; the role of the nucleic acids.) *Presse méd.*, July 4, 1951, *59*, 933–935.

The cancer cell, like all actively metabolizing cells, is characterized by a large amount of the nucleic acids, both thymonucleic and ribonucleic. Malignant tumors generally are richer in these two acids than benign tumors of the same series. At the Anti-Cancer Center of Marseille it was found that if tissues are arranged in a decreasing order of their radiosensitivity, it is the same order as that obtained by arranging them in a decreasing content of nucleic acids. After reviwing pertinent literature regarding the in vitro reaction, the authors report that radiation produces a diminution in the demonstrated nucleic acid in the irradiated cell.

Study of a radiosensitive basal cell epithelioma as well as lymphoblastoma, for example, showed the cell nucleus occupying a large part of the cell volume and rich in thymonucleic acid. The thymonucleic/ribonucleic acid ratio is elevated because the cytoplasm which contains ribonucleic acid is poorly developed in relation to the nucleus.

The authors' conclusions are:

1. The radiosensitivity of a cell is proportional to its nucleoprotein content.

2. Radiosensitivity is greatest when the ratio of thymonucleic/ribonucleic acid is highest.

These new rules of radiosensitivity are not opposed to the laws of Bergonié and Tribondeau. On the contrary, they are complementary and explain apparent contradications.

It remains to discover by which mechanism the radiation acts on the cellular nucleoproteins. Is there a direct action or is the decrease in demonstrable nucleic acids after radiation due to changes in enzyme systems which interfere with cell metabolism?

In any case, the cytochemical detection of nucleic acids, combined with a method for their micro-assay should provide a method for determining in advance the behavior of human cells under irradiation.—*M. L. Sussman, M.D.*

Van Allen, Willard W. Secondary radiation limits in photofluorography. *Pub. Health Rep.*, June 1, 1951, *66*, 712–716.

The established standard of 300 milliroentgens per week for the protection of radiation workers, although generally observed, is believed to be too high, especially where certain parts of a technician's body may be exposed to roentgen rays. It is felt that radiation protection programs should be based on limiting exposure to the lowest pratical level within the maximum tolerance dose of 300 mr. per week.

It has been shown that a photofluorographic unit can operate at a personnel exposure level of 40 mr. per 10,000 exposures and therefore any other unit operating at twice this dosage level is giving inadequate protection to personnel, even though the total weekly dose is well under the specified 300 mr.

Radiation monitoring programs should be rigidly carried out, with ionization chambers or dental film badges. Dosages in excess of 40 mr. per 1,000 exposures for technicians and 30 mr. for clerks should be investigated and steps taken to correct the causes of excessive exposure. Tabular records of radiation exposure levels should be kept for individual employes as a means of indicating failures in the protective program. The calculation of radiation dosage on a "per 1,000" exposure basis is considered to be far more valuable than the mere determination of whether the weekly dose is less than 300 mr.; 7,500 exposures per week could be made by one technician and still remain within the maximum tolerance safety limit of 300 mr. This number is very rarely approached in practice.—*W. M. Roy, M.D.*

Zimmer, E. A. Methodische Bemerkungen und Leitsätze zur direkten Röntgen-Vergrösserung. (Technical and other remarks on direct roentgen magnification.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Sept., 1951, *75*, 292–302.

The method of using a pin-hole in lead, close to the focus of a broad focus tube has been used in the past, the hole acting as a new and small focal spot. The disadvantage is the small amount of roentgen rays that pass permitting only long exposures. With the small focal spot, the object examined can be fairly distant from the film, thus permitting magnification of the image.

The Phillips 0.3 mm. focal spot tube has the advantage of a small source with a greater intensity. Geometric unsharpness is reduced to such an extent that in contact or short distance work, *e.g.*, temporomandibular joints, the detail of structures nearest the tube is sufficiently prominent to be disturbing. However, in doing magnified work, this is compensated for by the greater increment in distortion of the part nearest the tube, as compared with the part nearest the film. The author's techniques for skulls are usually at 40 cm., with the skull midway between the focal spot and the film. Magnification makes the best immobilization necessary. Finer grain screens are used for better detail.

The closeness of the part to the tube results in rather high dosage; therefore, a 7 cm. compression tube is used to keep from getting too close to the roentgen tube. Higher kilovoltages and dispensing with the Bucky diaphragm minimize exposure, and a 3 mm. aluminum filter is used to cut out the softer radiation. The Bucky diaphragm is not so necessary because the distance of the part from the film allows much of the secondary radiation to be absorbed in the air.

Enlargements up to 2½ times normal are quite good, but there is some decrease in sharpness at 3 times normal.—*J. J. B. Light, M.D.*

Fletcher, Gilbert H., and Matzinger, Karol E. Value of soft-tissue technic in the diagnosis and treatment of head and neck tumors. *Radiology*, Sept., 1951, *57*, 305–329.

This paper concerns itself with the diagnosis of soft tissue tumors and soft tissue extensions of tumors of the nasopharynx, oropharynx, laryngohypopharynx, cervical esophagus and the thyroid.

The interpretation of the roentgen findings rests on the evaluation of the density, size and anatomical relationships of small soft tissue structures.

Lateral roentgenograms are obtained with the patient placed in a chair. The chin is elevated and the shoulders lowered. A long target screen distance (72 inches) should be employed and the roentgen-ray beam must be aimed at the proper level. High kilovoltage technique, 100 kv. and around 2 ma. at 1/20 second, is advocated for excellent soft tissue detail.

Special views are required for the different sites. For the nasopharynx, after instillation of lipiodol in both nares, a roentgenogram is made with the patient lying on his back in hyperextension. For the laryngopharynx, roentgenograms are also taken during the Valsalva maneuver and during the phonation of "a." For oropharynx and laryngopharynx, lateral and anteroposterior roentgenograms are taken after ingestion of barium. For tomograms of the larynx and pharynx, the patient is placed in the supine position with the chin raised. The exposure is made during a slow inspiration which opens the glottis.

By these roentgenographic means a small soft tissue mass can be demonstrated, usually obliterating the normal sharp posterosuperior angle of the roof of the nasopharynx. Upward extension into the base of the skull is demonstrated in the submentovertex view. Downward extension, into the oropharynx and hypopharynx, is seen only in a soft tissue profile roentgenogram.

Lateral roentgenograms in the region of the oropharynx are most useful in determining the degree and direction of extension of the disease.

Rather than classifying lesions of the larynx and hypopharynx as extrinsic or intrinsic, the authors prefer an anatomical classification as (a) supraglottic (b) glottic and subglottic. This is elaborated upon. The roentgen examination includes lateral soft tissue roentgenograms and frontal tomograms. Obliteration of the pyriform sinus is almost pathognomonic of a tumor at this site.

The nasopharynx and pyriform sinuses are the most frequent primary sites for lymph node metastases to the head and neck.

Information gained through proper roentgenographic examinations is of value in (1) deciding upon the treatment of choice (surgery or irradiation), (2) determining the prognosis in either instance, (3) helping to plan the radiation therapy or the surgical procedures, and (4) evaluating the results of treatment.

Twenty-four excellent figures of diagnostic roentgenograms with accompanying artist's drawings outlining pertinent findings are included.—*E. E. Seedorf, M.D.*

Radiation Chemistry. A symposium of six papers read at the Sixth International Congress of Radiology, London, July, 1950.

I. Allsopp, C. B. Radiation chemistry in relation to radio-biology. *Brit. J. Radiol.*, Aug., 1951, *24*, 413–416.

Radiation chemistry, the science of the effects of ionizing radiations, is to be distinguished from photochemistry and radiochemistry. In considering the biological effects of these ionizing radiations, Allsopp points out that we are dealing with the effects on water and on dilute aqueous solutions.

At the time of the Fifth International Congress of Radiology which was held in Chicago in 1937, the biological effects of radiation were placed into two categories, as they were thought to be caused by "target" action or by "poison." The target effect was pictured as the result of ionization in or in the immediate vicinity of some particular molecule or vitally important structure in a larger organism. This was thought to be the mechanism in the killing of larger viruses and bacteria and the production of gene mutations.

The "poison" theory which was not universally accepted previously has been gaining momentum since 1937 with advance in knowledge of cell physiology, and of the effects of radiation on a dilute solution.

II. Burton, Milton. Elementary processes in the radiation chemistry of water and implications for radiobiology. *Brit. J. Radiol.*, Aug., 1951, *24*, 416–422.

When high energy radiation acts on water, a large number of products may develop, mainly as a result of ionization of the water. In addition to the production of hydroxyl ions, hydrogen ions and atoms, if there is oxygen present dissolved in the water, hydrogen peroxide and hydroperoxyl radicals are found. The amounts of each of these products present in any sample, and the types of interreaction they will undergo depend on the amount and nature of any other material, organic or inorganic, in the solution, and the type of radiation to which it is subjected.

When there is an organic globule suspended in the water, the liberated active ions may enter into reaction with the material of the organic globule. In

other words, the irradiation does not have to hit the globule to affect it; and this has the total effect of making the target larger than it would be if the solute were not there.

III. Bonét-Maury, P. Hydrogen peroxide formation in water exposed to ionizing radiations. *Brit. J. Radiol.*, Aug., 1951, *24*, 422–428.

Bonét-Maury investigated the production of hydrogen peroxide in water exposed to various ionizing radiations. He found that when water was irradiated with roentgen rays, the production of hydrogen peroxide varied with the intensity, the temperature, and the amount of dissolved oxygen. It was also affected by the hydrogen ion concentration. When water was irradiated with alpha particles, there was strict proportionality between the dose and the amount of hydrogen peroxide formed. The dissolved oxygen, temperature and hydrogen ion concentration had no effect. Very low concentrations of hydrogen peroxide were observed in samples irradiated in a pile.

These results can satisfactorily be interpreted on the basis of a chemical and a physical hypothesis, the latter dependent on the spatial arrangement of the various ions produced. Although the tendency is to explain all radiobiological reactions on this basis, it is probably true that the effect is very variable. The formation of hydrogen peroxide is probably one of the first links in a chain of reactions which occur in irradiated material.

IV. Dainton, F. S. A review of the evidence for the production of free radicals in water consequent on the absorption of ionizing radiations. *Brit. J. Radiol.*, Aug., 1951, *24*, 428–433.

Dainton presents chemical evidence supporting the theoretical expectation that hydrogen atoms and hydroxyl radicals are produced non-uniformly. The evidence for the existence of certain other activated particles is more equivocal.

V. Dale, W. M. Some aspects of the biochemical effects of ionizing radiations. *Brit. J. Radiol.*, Aug., 1951, *24*, 433–435.

Dale discusses the effect of irradiation on some enzymes. During his early investigations he noted that the absolute amount of enzyme destroyed by a given dose of irradiation is constant and independent of the concentration of the enzyme. Thus, it was shown that radiation acts indirectly on the dissolved enzyme through first acting on the solvent. Further experiments dealt with irradiation of two components of a substance singly and in combination, with the specificity of radiation effects and with the efficiency of densely ionizing radiation, as opposed to less densely ionizing radiation, by comparing alpha particles and roentgen rays. The most recent experiments have shown that certain amino acids release hydrogen disulfide under irradiation.

VI. Minder, W. Radiation chemistry of organic halogen compounds. *Brit. J. Radiol.*, Aug., 1951, *24*, 435–440.

Minder states that it is necessary to study simple systems to determine the basic effects of irradiation. Most biological systems are too complex for this sort of study. Up till now, four different types of radiation effect with increasing dose have been described. They are: (a) the proportional; (b) the delayed linear; (c) the exponential; and (d) the delayed exponential types. An example of the first is the oxidation of ferrous sulfate by gamma rays; it is governed by a single constant figure. The second type of reaction is very common and is found in almost all experiments in which halogen acids are formed by irradiating aqueous solutions of halogen-substituted hydrocarbons. An example of the third type of relation is seen in the irradiation of carbon tetrachloride in alcohol. The fourth type of relation is unusual.

These relations hold only as long as the amount of the reaction product is small compared with that of the reacting substance. It should be further noted that conduction of energy from the point of absorption to the point of action must be effected by diffusion phenomena, usually thought to be by means of wandering elements as hydrogen atoms and hydroxyl radicals.

Numerous halogen compounds in aqueous solutions show no dependence of ionic yield on concentration over a wide range until the concentration is decreased below a critical value. This has led to the concept of "reacting volumes," to each of which the energy of one ionization (32.5 ev.) must be imparted in order that the probability of forming one halogen ion measured as halogen acid from one molecule of the reacting substance would be unity. The figures obtained for these volumes suggest the existence of real or virtual molecular agglomerations in liquids or biological systems. Within these agglomerate masses, energy conduction is apparently possible in all directions without appreciable loss.—*E. F. Lang, M.D.*

Bonét-Maury, P., and Patti, F. Lethal irradiation of mice with high doses of roentgen and gamma rays. *Radiology*, Sept., 1951, *57*, 419–423.

The mean survival times of white mice subjected to increasing lethal total body irradiation are determined and expressed graphically.

The mice were selected from a heterogeneous population. A 200 kv. roentgen generator delivering 470 r per minute at 23 cm. distance through 1 mm. Al filter was employed. For the factors used, 100 per

cent mortality occurred at approximately 800 r; hence the curve is started at this point. The mean survival time then remains constant at approximately eighty days for total dosages ranging from 800 to 13,000 r, after which it falls off logarithmically to a mean survival time of two hours for a total single dose of approximately 60,000 r. One hundred per cent mortality during irradiation occurred at approximately 100,000 r. The eighty-nine day plateau suggests that death within this range is due to injury of a "target" (may be spleen) corresponding to an essential vital mechanism. The logarithmic curve above 13,000 r suggests that death is due to injury to the entire organism.

The above mentioned plateau was not reached in a similar attempt with gamma rays because the telecurietherapy bomb used had a dosage rate of only 3 r per minute.—*M. B. Goodwin, M.D.*

Hursh, John, B., van Valkenburg, Priscilla A., and Mohney, John B. Effect of roentgen radiation on thyroid function in rats. *Radiology*, Sept., 1951, *57*, 411–418.

Forty-eight adult albino rats, including 12 controls, were irradiated with roentgen rays (250 kv., Cu and Al filter with half-value layer 2.15 mm. Cu, 30 cm. distance, circular field 1.5 cm. diameter) applied locally to the thyroid area at total dose levels of 3,000, 4,500, and 6,000 r, the two higher doses being divided for delivery on consecutive days. Thyroid function was tested by injecting I^{131} at 7, 14, and 21 days after irradiation, sacrificing the animals four hours after intravenous injection, and analyzing the excised thyroid gland for uptake of I^{131} and for the percentage of this iodine which was organically bound. Within the limits investigated, the iodine uptake expressed as organically bound iodine increased as a function of the dosage and/or the time. This differs from the work of Bender where the basal metabolic rate showed no significant change with the amount of irradiation to the thyroid area of rats calculated over a postirradiation period of one month. In spite of the increased iodine uptake, no morphological changes of the thyroid could be demonstrated on the basis of examination of random sections. The increased uptake is tentatively regarded as an indirect consequence of a systemic response to irradiation, rather than any local effect.

The level of local roentgen irradiation necessary to produce destructive changes of thyroid tissue in the tested rats is greater than the highest dose (about 5,000 r, delivered as a single dose) that can be administered without causing death.—*M. B. Goodwin, M.D.*

Johansen, Robert, Gardner, Richard E., Galante, Maurice, Marchi, Floyd F., Ledwich, Thomas, W., Soley, Mayo H., Scott, Kenneth G., Miller, Earl F., and McCorkle, H. J. An experimental study of thyroid regeneration following subtotal thyroidectomy. *Surg., Gynec. & Obst.*, Sept., 1951, *93*, 303–309.

Several reports on the powers of regeneration of thyroid tissue have appeared in the literature over the past six decades. Early reports by Wagner (1884), Horsley (1886) and Halsted (1896) regarding the hypertrophy of residual thyroid tissue following partial thyroidectomy, and other studies on thyroid regeneration, were not concerned with the actual weight increase in the residual gland. Since Halsted's extensive review of the problem, numerous advances in the knowledge of the physiology of the thyroid gland have been brought about by different methods of study, *e.g.*, the use of radioactive iodine as an indicator of thyroid physiology.

In order to study the behavior of residual thyroid tissue following subtotal thyroidectomy, a group of experiments on albino rabbits was carried out. Correlated changes in the weight and histology of regenerating thyroid and in the protein bound iodine levels of the blood were demonstrated, and an attempt was made to use the uptake of radioiodine as an indicator of thyroid activity.

Summary and Conclusions. Following subtotal thyroidectomy in rabbits, the residual thyroid tissue undergoes considerable increase in weight. Histological evidence of hyperplasia is present three weeks after subtotal thyroidectomy and decreases somewhat by the twelfth postoperative week. Apparently significant variations in the blood iodine levels occur concurrently.

Radioactive iodine uptake studies following subtotal thyroidectomy indicate that the residual thyroid tissue takes up less radioiodine than the normal thyroid before operation; however, the concentration ability of each milligram of thyroid tissue is increased. After subtotal thyroidectomy the residual thyroid tissue takes up the radioiodine to a maximum level within the first twenty-four hours, while the normal thyroid before operation has a maximum uptake at forty-eight hours after the administration of the isotope.—*Mary Frances Vastine, M.D.*

Meeker, Irving A., Jr., and Gross, Robert E. Low-temperature sterilization of organic tissue by high-voltage cathode-ray irradiation. *Science*, Sept. 14, 1951, *114*, 283–285.

A series of bacteriologically contaminated canine aortic segments were irradiated with a 3 mev. cathode-ray generator. The segments were sealed in plastic bags, frozen and irradiated at a carbon dioxide ice temperature with a total dose of 1.5 to 6 million rep. Of the original 125 segments only 3 grew organisms after culture for seven days in beef heart broth.

In another series 194 human aortic segments ob-

tained routinely during autopsy were frozen. Of these, 94 specimens were thawed and irradiated at room temperature, and then cultured; 3 were positive. The remaining 100 were irradiated while frozen. On culture, 2 were found positive. When frozen but unirradiated controls were cultured, all were positive.

Five dog arterial segments were transplanted after being irradiated with 1.5 million rep at room temperature. These proved unsatisfactory due to formation of occluding thrombi. In contrast, 38 frozen dog aortic segments when irradiated at a dry ice temperature with 1.5 to 2.0 million rep and transplanted had no large occluding thrombi.

Another group of 22 unsterile segments treated with from 3.0 to 6.0 million rep at a low temperature showed degenerative changes.

Apparently at a low temperature the vessel wall is protected (below 3.0 million rep) but the bactericidal effectiveness is not altered.

The above findings are explained by the fact that reactive radicals formed during irradiation of water have a reduced mobility at the low temperature, and therefore their effect on the vessels is minimized. The direct effect of ionizing radiation is independent of temperature changes and is believed to be sufficient to effect the genes and chromosomes of the microorganisms and eventually to be lethal.

Using the above method it is possible to sterilize arterial segments without significant damage to tissue. Two patients with coarctation of the aorta have had frozen, irradiated human aortic segments grafted and have been followed for four and six months postoperatively with excellent clinical improvement.—*Z. S. Gierlach M.D.*

Radiotherapeutic Physics. At the Sixth International Congress of Radiology, London, July, 1950, the following excellent papers on Radiotherapeutic Physics were presented. They deal primarily with the problems of dosage estimation in roentgen-ray, teleradium, and interstitial gamma-ray therapy. The emphasis placed on this phase of radiotherapeutic work is timely since much pioneer work must yet be done before the problems of predetermining dose are satisfactorily solved. A preview of new instruments and equipment for therapy, dosage determination and monitoring shows that significant advances have been made and that many more are in the making.—*K. L. Krabbenhoft, M.D.*

I. JOHNS, H. E., DARBY, E. K., and KORNELSEN, R. O. The physical aspects of treatment of cancer by 22 MeV x rays. *Brit. J. Radiol.*, July, 1951, *24*, 355–364.

The authors report techniques developed for the dosage control of betatron radiation. The surface dose on a scattering medium is small when a high energy roentgen-ray beam free of stray electrons strikes it. The dose increases to a maximum some distance below the surface at the point where the primary and secondary radiation reaches an equilibrium. The measurement of surface dose, therefore, depends upon the wall thickness of the detector. For this purpose of determining skin dose a special ionization chamber was constructed. The front and back walls of this flat ionization chamber were of bakelite 0.5 mm. thick, internally coated with aquadag, enclosing an air space 2.0 mm. thick. The current of the collecting electrode of fine aluminum wire was amplified and measured on a D.C. amplifier. The chamber was placed in front of the betatron (22 mev.) with the copper compensating filter in place. Thin layers of lucite were placed immediately in front of the chamber and converted into cm. of water. The minimum response was 19.5 per cent for 0.5 mm. of bakelite and extrapolation to zero thickness yielded a value of 15 per cent. There are always some Compton electrons and electron pairs produced in the air in front of the ionization chamber which would account for at least a portion of the 15 per cent received on the surface. The depth dose expressed as a percentage of the dose at the maximum is proportional to $e^{-\mu_1^x} - e^{-\mu_2^x}$ where μ_1 and μ_2 represent the absorption coefficients for the primaries and secondaries respectively. This yields the zero depth dose for x to equal zero. This could only be anticipated when dealing with a high energy gamma-ray beam free of electrons.

A "treatment cone" is used to mark the entrance point of the beam on the patient, consisting of a galvanized iron tube fastened to the front shield of the betatron. It fixes the focus skin distance but does not determine field size. This is delinated by a removable lead plug. The end of the treatment cone is covered with a layer of balsa wood 3 mm. thick which corresponds to 0.8 mm. water and increases the skin dose from 15 to 21 per cent of the maximum. Numerous investigators have demonstrated that the dose in the very superficial layers of the skin is of little biological significance, whereas that received 2 to 4 mm. below the skin surface is of much greater importance. At 2 mm. depth the dose is increased from 32 to 36 per cent when the wood is used. Where opposing fields are used the principal component of skin dose (60 per cent for a patient 18 cm. thick) comes from the remote field. Therefore, the total skin dose is raised from 92 to 96 per cent with the use of the wood end which is negligible where tumor doses of 200 to 300 per cent are attainable with ease. Skin dose is never a problem with betatron radiation and is taken to be about 40 per cent for practical application. The exit dose can be predicted from the depth dose curve for high energy radiation.

It was found that the collimating parts did not significantly contaminate the beam with stray elec-

trons if these parts were 40 cm. or more from the skin surface. In the authors' betatron, the lead plug is 50 cm. from the end of the cone and the copper compensating filter and monitor are 80 cm. from the end of the treatment cone. A detailed description is given of the master collimator, monitor, compensating filter, removable lead plug, and the treatment cone. Rectangular fields of 15 by 6, 15 by 10, 10 by 8, 10 by 6, and 8 by 6 cm. have been found most useful. The copper compensating filter is necessary to obtain a flat isodose curve but does not change the spectral distribution of the radiation. Accurate alignment of the betatron beam is very difficult and is one of the disadvantages encountered in its use. The axis of the beam and the axis of the collimator must coincide precisely for the copper compensating filter to function properly in producing the desired isodose curve. The technical aspects of the problems encountered are fully elucidated.

The monitoring integrator used in predetermining the delivered betatron dose is diagrammed and thoroughly explained. The dosage rate at the end of the treatment cone with the filter in place is about 70 r/min. and without the filter it is about 150 r/min. at 1 meter. At the monitor, the dosage rates are approximately 1600 r/min., produced by bursts of radiation lasting 1 μsec., 180 times per second. Therefore, the instantaneous dosage rate is very high and collecting all of the ions under these circumstances requires great care. With the use of a special monitor, 99 per cent of the ions have been collected.

It was determined in dosimetric measurements that the response of a Victoreen chamber in lucite compares favorably with that of a true air-wall chamber. Various wall materials were used for the thimble chamber and calculations made which are tabulated. Formulae are given which permit theoretical calculation of the percentage depth dose and integral dose. These results coincide reasonably with curves obtained by evaluating the volume between successive isodose curves where the integral dose is concerned. For the same techniques and tumor dose, the integral dose using 22 mev. radiation is from one-half to one-third of the dose with 400 kv. radiation, which is one of the main advantages realized from the use of this high energy radiation.

Sloping fields cannot be avoided in some instances and in general the use of bolus material is disadvantageous because of the high dose created at some points on the skin. Where it is not used, ordinary isodose curves should be employed in estimating dose distribution and it has been found that these curves tend to parallel the skin surfaces.

As has been demonstrated by Spiers (1946), bone embedded in soft tissue preferentially absorbs low energy radiation due to the photoelectric process. The authors state that this same problem is encountered at very high energies due to pair production. Radiations of 500 kv. to 4 mev. energies are absorbed primarily by the Compton process and all materials absorb the same amount of radiation per unit mass. The radiation of the betatron operated at a peak energy of 22 mev. has an effective energy of about 7.5 mev. and at this level bone has a 6 per cent greater preferential absorption than at 2 mev. This is not considered to be a clinically significant increase and the corpuscular radiation at these energies have a sufficient range to give maximum energy absorption in the soft tissues beyond the bone in most situations.

This paper is well illustrated with photographs, diagrams, graphs, and tables.—*K. L. Krabbenhoft, M.D.*

II. Spiers, F. W. Dosage in irradiated soft tissue and bone (with an Appendix by W. J. Meredith). *Brit. J. Radiol.*, July, 1951, *24*, 365–370.

The limitations of quantitative estimation of tumor dosage made with the use of phantoms of various types are principally due to the presence of bone and lung tissue in the irradiated volume. Measurements in cadavers and calculations of energy absorption in substances of different effective atomic numbers by various investigators demonstrated the inaccuracy of the over-simplified phantom measurement. The author has previously demonstrated that differences in the relative linear absorption of bone, muscle, and fat determine the dose distribution in the body. He has also demonstrated the ranges of energy absorption per cc. of tissue per r in bone, muscle, and fat. In bone particularly, increase in wavelength increases energy absorption. Therefore, bone interferes with dose distribution to tissue beyond it and with its greater energy absorption, the living elements within bone are subjected to a higher dose.

A more detailed study was made applying these principles to the dose distributions along the central axis of six fields used in irradiating an esophageal lesion with 200 kv. (half-value layer of 1.5 mm. Cu) radiation. The thickness of bone, fat, muscle, and lung tissue (the latter assumed to have a mean sp. gr. of 0.5) in the thorax were plotted and their densities, effective atomic numbers, and absorption coefficients utilized in constructing depth dose curves for the various fields. A table further illustrates these percentage depth doses and demonstrates that the posterior field through the spine is very inefficient. In the other fields, the total dose approaches that for a uniform medium since the lung and bone compensate for each other.

Elaborate determinations were made to show the magnitude of dosage in soft tissue surrounded by (1) bone, (2) soft tissue, and (3) fat. It is of importance to recognize that the osteocytes and capillary tissue in the haversian systems of bone are the elements concerned in the radiation "reaction" of bone. The type of tissue surrounding the area of interest is a

determining factor and the energy range of roentgen rays used greatly influences the degree of ionization taking place. The author states that the permissible dose in roentgens to bone is about one-half that tolerated by soft tissues in the 200 kv. range and may be no more than one-third for medium and superficial voltage ranges. He concludes that radiation of energy greater than 1 mev. is necessary to minimize the damage to the living elements within the bone.

In an appendix to this paper, W. J. Meredith of the Christie Hospital and Holt Radium Institute of Manchester, describes a complicated method of estimating doses at any depth which allows for multiple scattering. In an earlier paper by Spiers (1946) an attempt in this regard was made in reference to a heterogeneous medium using standard percentage depth dose data and the absorption coefficients of the materials in the medium. The radiation reaching a point in a homogeneous medium is analyzed for its primary and secondary components, the scattered component being analyzed for forward scatter and back scatter; then the amount of each type of radiation reaching the point in question is estimated. Applying this method to a heterogeneous medium, allowances are made for the different absorption and scattering properties of the layers.

Meredith made several simplying assumptions since the scattering of a roentgen-ray beam is highly complex. For example, he made no allowance for the change in wavelength of the scattered radiation or for the divergence of the roentgen-ray beam. This method, illustrated by a formula and diagram, provides for calculating the dose at a given point by adding (1) the primary radiation and its back scatter, (2) the back scatter from the material above this point (based on figures published by Quimby, Marinelli and Farrow, 1938), (3) the forward scatter from the primary beam, (4) the backscatter from this forward scatter, and (5) the back and forth scatter of the tertiary radiation, etc. The contribution of forward scatter is calculated and tabulated, based on the total and primary dose figures of the Mayneord-Lamerton tables (1941). Backscatter values reaching the surface from a 1 cm. slab situated at various depths are calculated and tabulated. These determinations were made on a homogeneous (water) medium with radiation of H.V.L. 1.5 mm. Cu, F.S.D. 40 cm. and field 100 sq. cm. In applying these data to heterogeneous media, the individual contributions of substances of varying density must be corrected due to the fact that (1) the primary contribution to any level is changed by other levels of increased or decreased absorptive ability, (2) the substance may scatter differently from water, (3) the scattered radiation may pass through areas of greater or smaller absorptive ability.

It is concluded that the method described by Spiers is simpler and compares closely in estimated dosage to this complex and rather unwieldly method. Accordingly, this means of analyzing estimated depth dose been abandoned.—*K. L. Krabbenhoft, M.D.*

III. Benner, Sven. A survey of hospital physics activities at the Institute of Radiophysics, Stockholm. *Brit. J. Radiol.*, July, 1951, *24*, 370–374.

One of the recent developments at the Institute of Radiophysics in Stockholm is the large "flash-roentgen" tube recently described by Sievert *et al.* It has neither reached a stage of perfection nor of practical therapeutic application but does appear promising. A large high voltage condenser bank (0.27 μf, maximum voltage 1 mev.) is charged by a six-stage Cockcroft-Walton type cascade generator. The bank is then switched from the generator to the high voltage positive terminal of the roentgen tube, through which it is discharged at a rate of several thousand amperes in 10–100 microseconds. The power dissipated in such a discharge is 100,000 kw. or more, and to withstand this, the loaded anode surface must be very large. In therapeutic work, the anode can be constructed so as to give simultaneous cross-fire irradiation. This construction is conical in shape with a maximum diameter of about 480 mm. and height of 200 mm. A circular diaphragm defines the hollow conical beam externally and the anode delimits the internal border of the beam. Photographic determination and photometric measurement of the beam reveal an ideal dosage distribution in the phantom. As the voltage is increased, the depth dose will increase considerably. Repeated flash irradiations from different portals will raise the tumor dose further. At full voltage, each flash will give a dose of approximately 50–100 r. The time factor in delivering the dose may be exceedingly important here and must be assessed before human application is made of this equipment.

Further progress in the development of measuring instruments used for rapid dose distribution measurements around radium containers and applicators is in the form of a simple electronic dosage-rate meter. This consists of a small ionization chamber attached by a stiff metal tube to a handle enclosing a Victoreen VX 41 electrometer tube. By a multiple-conductor cable, this is in turn connected to a box containing the other requisite elements of the set.

An instrument for measuring dosage rate within a medium containing an evenly distributed radiating substance consists of a horizontal electrode surrounded by a guard ring suspended above the solution surface. Another instrument, designed by Sievert, for measuring neutron doses is made with a wall of cellulose sponge soaked in water. The wet sponge has a solid matter content of 7 per cent. A differential chamber is added to distinguish between neutron and gamma-ray effects when simultaneous irradiation of the two types is being measured. The

electrometer tube measuring system in these two instruments will have to be exchanged for the condenser chamber principle when used in measuring radiation fields near cyclotrons, betatrons, and other apparatus associated with a strong magnetic field.

Protection measurement instruments which have been developed are a light-weight photometer with a fluorescent screen indicating dosage rates as low as 1.5–2 milliroentgens per hour. Another instrument is a double condenser chamber with two measuring ranges for monitoring sources of uncertain magnitude and, where very large doses are measured, a condenser chamber with very low gas pressure is used in which secondary electron emission from the electrodes replaces gas ionization. A future projected measuring instrument, not yet tested experimentally, is a combined dose meter and dosage-rate meter, making both measurements simultaneously. The author feels that this will be of particular value in rotational roentgen therapy.

The Swedish physicists do not take an active part in treatment planning and execution to the degree practiced in England. Their work is chiefly concerned with standardization of machines, protection problems, and routine checks on treatment techniques to insure constancy and uniformity.—*K. L. Krabbenhoft, M.D.*

IV. Wilson, C. W. Some developments of the physical aspects of teleradium therapy. *Brit. J. Radiol.*, July, 1951, *24*, 374–380.

In outlining the developments of the physical aspects of teleradium therapy which have occurred since the last International Congress of Radiology in 1937, the author first describes the apparatus for the application of this modality. Two radium mass units have been in use at Westminster Hospital, London, since 1936. One of these, a 4 gm. unit, utilizes a radium-skin distance of 8 cm. and two circular ports of entry of 3.5 cm. and 9 cm. diameter. The other, a 2 gm. unit, is employed with a radium-skin distance of 5.3 cm. and a single port of entry of 3.5 cm. diameter. These units have tungsten alloy for protection material. The radium is permanently housed in the treatment container which requires expedient application of the units to the patient to avoid excessive exposure to the operator. A 5 gm. unit, installed at the Radium Beam Therapy Research in 1936 (described by Grimmett) features a pneumatic device for loading and unloading the radium automatically. This arrangement decreases the protection problem to a large extent since the radium element is not in the unit while it is being applied to the patient. Later, similar units were installed at other centers in Great Britain. Detachable nozzles were also developed which provide rectangular fields, thereby increasing their usefulness.

Post-War teleradium units were planned to contain 10 gm. of element and the projected availability of radiocobalt was anticipated. Uranium was thought to be the ideal protection material, replacing tungsten alloy. Uranium was also to be used in making the nozzles. The availability of uranium metal in quantity became a reality due to war-time atomic energy development. The first such unit containing 10 gm. of radium element was installed at Westminster Hospital in November 1948. By the employment of an insert of uranium metal, these units can be used with more than one radium-skin distance. The Westminster unit had a radium-skin distance of 8.5 cm. and, with the additional extension piece, this was increased to 11.4 cm. Detachable uranium nozzles with circular fields of 5 cm. and 8 cm. diameter and rectangular fields of 4 by 4 cm., 7 by 4 cm., and 8 by 5 cm. were used. The expected absorptive properties of uranium have been fully realized. Dose contours of the beam were determined with ionization measurements within a water phantom.

Since 1937, closer radiologist-physicist working relationships have resulted in more precise application and control of treatment. This work principally concerned the establishment of isodose curves, the appreciation of uniform irradiation within a given volume of tissue, and the determination of exit doses. Treatment planning then entered a stage of designing the portals, with the dose distribution and contours the prime consideration.

After accurate topographical localization of the lesion to be treated, the first step is to determine the number, position, and direction of the beams required to obtain the desired dose distribution. The central rays of all the beams are most conveniently arranged in a common plane. From this, the dose at the tumor, the skin or any other point can be predicted and a diagram is made. The next step concerns the clinical application of these field arrangements, using such mechanical aids as calipers, beam directors, jigs, and plaster casts. The author has had considerable previous experience with metal framework jigs, and these same principles were applied to the 10 gm. unit by the use of plaster casts with mounted wax seatings to localize and direct the various beams. Absorption within the cast is negligible.

A cast is made for each patient treated with the 10 gm. unit. Most of these patients have lesions about the head and neck.

Numerous photographs and diagrams illustrate the text.—*K. L. Krabbenhoft, M.D.*

V. Meredith, W. J. Doasge control in interstitial gamma-ray therapy. *Brit. J. Radiol.*, July, 1951, *24*, 380–384.

This paper reviews the progress in dosage control of interstitial gamma-ray therapy for the past

fifteen years. Despite the disadvantage of the necessity of surgical intervention with radium implantation, the advent of supervoltage roentgen therapy, and other methods which have largely replaced this form of therapy, the author points out that many radiologists still regard the implant as an excellent means of delivering a high dose of gamma rays to a limited volume of tissue without excessively irradiating surrounding tissues.

In interstitial therapy, efficient methods of dosage control are imperative. With the appearance of the Paterson and Parker (1938) dosage system, the long-needed data of dosage rate and distribution in tissue blocks of various shapes and sizes were made available. In spite of the precise nature of treatment planning which can be accomplished on the basis of the above data, technical limitations are frequently responsible for the actual implantation differing from the "blueprint." To more accurately determine the dose distribution from the actual implantation, three general methods are employed: (1) direct ionization measurements on the patient, (2) ionization measurements or calculations on reconstructions of the implant, and (3) calculations on roentgenograms of the implant.

The direct ionization measurements are most appealing to the physicist, despite the many obstacles encountered. It is difficult to place the chamber where the measurements should be made and due to the short distance from the radium, the chamber must be small, and consequently its degree of sensitivity is low. Benner (1934) made one of the earliest attempts at direct measurements and used needle-shaped condenser chambers near implanted needles and paraffin-mounted needles. Fairly accurate correlation between theory and experiment was obtained. Later, postmortem tongue specimens were used by others to reconstruct successful implants and assess surface doses. Wide variations were encountered, but a valuable knowledge of the dosage in roentgens required for successful treatment was gained. These and other types of surface measurement are useful in shallow implants where surface dose is the limiting factor but are of little value in deep implants. To more accurately measure dosage in volume implants, small condenser chambers were inserted, within a needle-like probe, into the tissues and good correlation was obtained between calculated and measured dosages. This method is the most acceptable thus far developed, but to reduce trauma, the device must be reduced in size. Minute Geiger counters have also been tried experimentally but without outstanding success.

The use of implant models for ionization purposes has been explored rather extensively. Numerous methods employing reconstructions based on roentgenograms have been described. For estimating separation in a curved two-plane radium implant or determining the area of a curved radon seed implant, this method is probably the most accurate. Furthermore, it can be handled and closely inspected, which is of great value in devising new techniques. Making reconstructions is tedious and time-consuming, however, and they are ill-suited for use in a busy clinic.

A practical method using roentgenograms of the implants is an outgrowth of the Paterson-Parker dosage system and the Holt Radium Institute's philosophy on dosage. A block of tissue slightly larger than the entire tumor is implanted with the most desirable and simple arrangement. The dose in the entire area is then raised to a tissue tolerance level. Since the implants are simple in shape, ascertaining the size in area or volume allows the dose rate to be easily calculated. The roentgenograms are made in planes perpendicular to one another, occasionally supplemented by special views. A metal ring, equidistant from the implant in both projections is placed on the patient's skin to determine the degree of magnification. Roentgenograms illustrating this method are reproduced in the text. This method is simple and does not require an inordinate expenditure of time, although it is somewhat limited in application to simple, geometrically good implants. A further advantage in the use of roentgenograms permits correction of a faulty implant by the addition or removal of sources shortly after the implantation.

In conclusion, the author points out that no one method of dosage control in interstitial therapy is entirely desirable and universally applicable. The department of radiation therapy must have more than one method available to be fully equipped. The reconstructive and roentgenographic methods are most useful, while the direct surface measurement has special indication and should be developed further. Close collaboration between the radiation-therapist and physicist is mandatory in developing the best dosage control and in selecting the particular method suited to each case.—*K. L. Krabbenhoft, M.D.*

VI. Lamerton, L. F. Some aspects of the problem of dosage estimation in x-ray treatment. *Brit. J. Radiol.*, July, 1951, *24*, 385–388.

Dosage estimation in roentgen treatment must be critically evaluated to insure the best use of our facilities and effort and to be of greatest assistance to those just organizing their own hospital physics departments. The provision of methods for dosage determination has been one of the major projects of the hospital physicist. The author regards the problem of dosage estimation in roentgen treatment as totally different from the problem encountered in assessing dosage from a discrete radioactive source, *i.e.*, radium. The roentgen ray, a source of radiation associated with scattering to a large degree, influ-

ences point dosage markedly, whereas radium, with hard radiation, is associated with a lesser degree of scattering. The degree of mathematical precision in radium dosage estimation is realized only in part where roentgen rays of 1 mev. or more energy are concerned. Since theoretical means are lacking in roentgen treatment, empirical methods must be employed and the principal tool used is the isodose curve. Should this method be elaborated and to what extent is this necessary?

First, the degree of accuracy in dosage estimation needed for acceptable clinical work must be ascertained. This is difficult due to other poorly understood factors, such as fractionation and biological and biochemical factors, which influence the success of treatment. An accuracy of 10 per cent is generally thought to be satisfactory. Second, the degree of accuracy of estimation using isodose curves is lowered by inconstancies of tissue density due to the presence of bones, air spaces, and the limited extent of the scattering medium. A step forward has been made in the form of direct-reading dosemeters with small chamber volume but unfortunately the information gained in this manner is applicable only to special cases, and the formulation of general principles will be delayed until a method is developed to compensate for inequities of tissue density. Third, the present methods of measuring dose from beamed radiations have marked limitations. These are not so pronounced where circular fields are used but are very definite where rectangular fields of irregular shape are employed. The increasing use of adjustable diaphragms for collimating the beam have made this deficiency glaring. There is an urgent need for the development of new methods of dosage estimation adaptable to routine use which are more generally applicable and which provide a fair estimate of accuracy. Such an instrument utilizing optical integration is described in Paper VII of this symposium.

A general method of dosage estimation must of necessity involve a knowledge of all contributing scatter from an irradiated volume at any given point. A limited analysis of this is possible, based on the variation of scattered radiation at a point on the central axis with changes in field size. Approximate estimations of dose at any point in an irradiated volume of any size and shape are possible utilizing this principle. If the variation of the central axis depth dose with the radius of field is known, increments of radius of field can be determined necessary to give equal increments of scattered radiation dose at a given depth on the central axis. A diagram is given and the annular elements of known dosage contributing value are divided into segments. The percentage each segment contributes to the depth dose is determined and by counting these segments, the percentage depth dose (in terms of air dose at the surface) can easily be calculated for fields of irregular shape. Then the depth at which the dose is desired in the patient is determined, usually by calipers, and the dosage estimation is made.

The author states that previous central axis depth dose values published by himself and the results of other investigators have proved to be in error to a rather large extent. With the development of practical instruments for direct measurement since then, these measurements should be repeated. They should also include a wider range of radiation energies than the previous study.—*K. L. Krabbenhoft, M.D.*

VII. Wheatley, B. M. An instrument for dosage estimation with fields of any size and shape. *Brit. J. Radiol.*, July, 1951, *24*, 388–391.

The author has made a device with which the routine estimation of dose using fields of irregular shape can be more generally accomplished. In principle, the instrument employs the idea that the dose of scattered radiation at given points on the central axis of a circular field varies with the field diameter, and on this basis an estimate can be made of the dose at any point in the irradiated volume of an irregularly shaped field. In the past, this integration has been carried out with the use of graphs and other cumbersome methods. With the apparatus described, this integration is done automatically and can be applied routinely. The dose (or percentage depth dose) at any point in a field represented by an aperture in a black paper mask moved over a transparent tube can be recorded appropriate to the quality of radiation, the focal skin distance, and the depth in tissue for which the machine is adjusted.

This is a method utilizing the principle of optical integration. A D.C. Pointolite lamp, run from a 100 volt battery provides a steady point source. The light is spread into a uniform field by a large lens. A transparent platform with a cutout of the field shape is placed in this uniform field. Below the platform, a sector is mounted in a slide on a rim-driven disc which can be rotated at variable speeds by an electric motor. The light transmitted by the sector and cutout is condensed by means of a lens, passes through a red filter, and strikes a selenium barrier-layer photocell which is connected to a heavily over-damped galvanometer with an adjustable shunt which can be read in roentgens. A second photocell which can be tilted toward or away from the light source provides a convenient means of introducing an additional current representing the primary depth dose.

For purposes of analysis, the irradiated medium is considered to be made up of a number of adjacent hollow conical shells. The scattered radiation at a given point on the beam's central axis at a given depth is a sum of the contributions of scatter from each of these shells. The contribution from a shell of a certain radial width can be determined from the

experimentally determined variation of central axis depth dose with field radius. The design of the sector which transmits these data into the instrument is such that the area of the sector between two radii is proportional to the contribution to roentgen-ray scatter from the shell formed between the same two radii. The transparent area on the rotating disc is measured by the response of the photocell and the estimate of dose is obtained.

In determining the dose at a specific point the method is similar except that an aperture is used in the paper mask.

Percentage depth dose values can be obtained directly by the use of a second photocell receiving light directly from the source which introduces an additional current.

The accuracy of this device for reproducing the data is within 5 per cent and results are rapidly obtained. It is well adapted for determination of dose at points in an irregularly shaped field, the study of distribution where parts of a field are partially or totally obliterated, and determination of complete isodose curves for various sized and shaped fields. It may be used in the future to formulate fundamental laws relating to dose due to scattered radiation at similar points in fields of similar shape which will facilitate determination of dosage data for reasonably symmetrical fields and produce empirical methods for their ready evaluation.—*K. L. Krabbenhoft, M.D.*

Donovan, G. E., and Jones, Glyn. Colour in radiography. *Proc. Roy. Soc. Med.*, Sept., 1951, *44*, 816–818.

Roentgen rays and visible light are part of the electromagnetic spectrum. The wavelength of visible light determines its color, and, in the case of roentgen rays, is the property akin to color. The kilovoltage applied to the roentgen tube governs its spectral emission. The roentgen rays are not monochromatic, but rather a spectral band. The ability of the roentgen beam to affect the film depends on its wavelength, thickness of the interposed part, and the atomic number of the atoms composing the part. The roentgenogram is a shadow picture in various shades of gray. The detail that can be seen is dependent upon the degree of translucency or opacity of the part being roentgenographed at the particular kilovoltage. Different detail is obtained by using different kilovoltage.

The colored roentgenogram is optically synthesized by first obtaining two or more conventional roentgenograms exposed at different kilovoltage, Each roentgenogram is tagged with a visible color. such as red, green, and blue, and the three colors are optically synthesized to produce a single colored image. The resultant colored roentgenogram, therefore, is not a reproduction of the colors of the roentgenographed part, but rather an optical synthesis to produce optimum contrast and differentiate the component shadows of the routine roentgenogram.

Four methods for producing colored roentgenograms from the conventional roentgenograms are available. These methods are (1) optical projection, (2) chromoscopic synthesis, (3) trichrome carbro method, (4) color roentgen transparencies.

(1) The optical projection method is probably the best. Each roentgenogram is projected on the screen in a different color. The projection is done in such a manner as to produce optical superimposition, thereby causing a colored roentgenogram in combined colors to appear on the screen, *i.e.*, the low kilovoltage roentgenogram can be projected in red, the medium kilovoltage roentgenogram in green, and the high kilovoltage roentgenogram in blue.

(2) The chromoscopic method uses partially transmitting mirrors and color filters. The partially transmitting mirrors perform the function of superimposing the images of the color separation negatives so that a single colored image is seen by the observer.

(3) The trichrom carbo method uses the roentgen images taken at the various kilovoltages as color separation negatives. A colored roentgenogram is therefore obtained in the form of a color print on paper. This photographic method is well known. The authors' method was to photograph two or more roentgenograms made at varying kilovoltage with a 35 mm. camera. A color filter is used for each roentgenogram. The film was not advanced so that each roentgenogram is projected onto the same frame. In this manner two or more roentgenograms were made to register in different colors on a single 35 mm. film frame.

(4) A careful choice of colors enables one to obtain a pseudostereoscopic effect.—*D. R. Bernhardt, M.D.*